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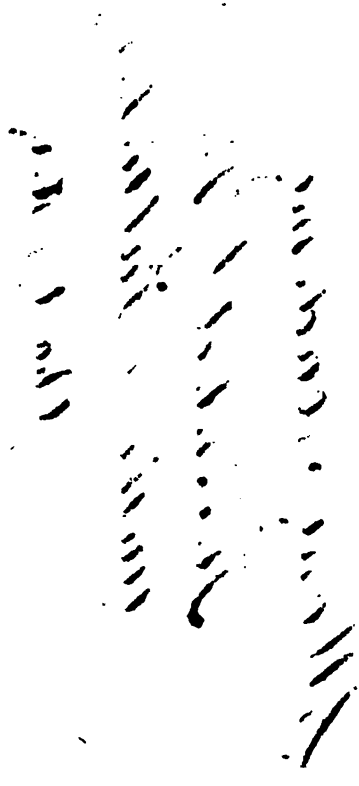

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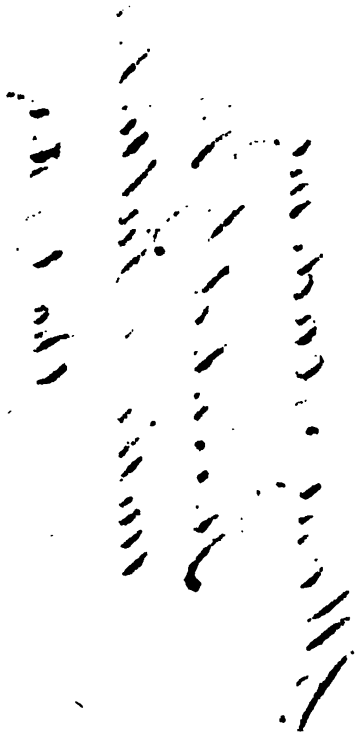

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INTRODUCTION

TO THE

STUDY OF GEOLOGY:

TOGETHER WITH

A KEY

TO

FOSTER'S GEOLOGICAL CHART.

BY J. T. FOSTER, A. M.

P. W. Groot Publisher

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PREFACE.

It is the design of the Chart and Key to unlock, as it were, a casket of useful knowledge, and present to the learner a compendious view of the science of Geology. The proprietor of landed estates, the artizan, and the manufacturer, should remember, that while they may all render this science subservient to their individual advantage, our national prosperity and wealth are derived in a great measure from our mines.

The author, being fully aware of the difficulties the learner has to encounter in reading voluminous treatises on Geology, has endeavored, by an easy description and concise explanation of the elementary principles, to give him a general knowledge of the science, without fatiguing his mind, or diverting his attention by the enumeration of endless varieties.

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GEOLOGY.

THE term GEOLOGY is derived from the two Greek words which signify *Science of the Earth*, "or that branch of natural history which treats of the physical constitution of our globe." The Earth has the form of a ball or spheroid, slightly flattened at the poles. Its diameter is about 8,000 miles, and its surface is irregular; here it is studded with long chains of mountains, there hollowed by deep depressions; but these irregularities, however gigantic they may appear, when compared with objects surrounding us, are in reality very trifling when compared with the mass of the globe. The inequalities are comparatively less than those we see upon the smoothest orange. Great masses of water conceal the deep excavations on the surface of the globe, but from the most careful examinations it is safe to conclude, that the most profound depressions do not exceed three miles in depth below the surface of the sea, and by exact measurement we know that the elevation of the loftiest summit is not more than six miles in height.

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It is evident that the crust of the Earth has not always possessed the same configuration that it now exhibits; it has been often upturned, and there is reason to believe that this entire globe was a liquid mass, melted by heat, and that it gradually became solid as it cooled. It is proved that the Earth possesses internal heat from the increase of temperature, which has been found to be equal to two degrees of Fahrenheit for every seventy or one hundred feet. It has been found by experiments made at Paris that the thermometer, at a little below the depth of two hundred feet, stood at fifty-five degrees. At the same ratio of increase of temperature, at the depth of a league it would be that of boiling water, and at less than two leagues the heat would be sufficient to melt tin.

The globe, as it appears, at some remote period was in a state of liquefaction from heat, and that it cooled by degrees, but this cooling process has not been continued up to the present time; it has almost if not entirely ceased. From the earliest records to the present time the temperature has not sensibly changed, and by calculations it has been ascertained, that the Earth receives about the same quantity of heat from the Sun that it loses in the same time.

Men, from the earliest antiquity, have been inquisitive in relation to the origin and duration of the Earth and the mutations which it has already undergone or

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is likely to undergo in future times. In the absence of positive knowledge in regard to the Earth's structure, curious theories have been invented, some of which it may not be uninteresting to examine.

The ancient Egyptians supposed this fair world was occasionally destroyed and again renovated under a new aspect; that a new creation of men and animals took place after every such renovation; and that the gods by such awful judgments arrested the career of human wickedness, and purified the habitations of man from his own guilt by deluges and conflagrations. The Egyptian priests assign certain periods of time for the destruction and renovation of the world; the periods of these catastrophes are variously estimated from 120,000 to 300,000 years. The Greek philosophers believed the Earth was liable to be afflicted by catastrophes of flood and fire.

Burnet's *Sacred Theory of the Earth*, supposed that the primeval world, down to the time of the flood, enjoyed a perpetual spring, and accounts for it by assuming that the plane of the ecliptic was then coincident with the Earth's axis, and that the commotion during the flood turned the Earth into its present position, and thus produced the vicissitudes of the seasons. According to his theory "the original form of the Earth, as it arose out of chaos, was so contrived as to contain within itself the water necessary to produce the deluge. A smooth crust of earth is made to con-

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ceal the waters of the abyss from the time of the creation, but the rain on the outside, together with the expansion of the waters beneath by heat, rent this crust, which falling down into the abyss caused the universal flood, and at the same time by the inequality of the fragments formed the mountains of the Earth, as we now see them." Not satisfied with these theories, he derived from the sacred scriptures and from heathen authorities, prophetic views of the future revolutions of the globe; and gave a terrific description of the final conflagration, and proved that a new Heaven and a new Earth will rise out of a second chaos, after which will follow the blessed millenium.

Woodword's theory supposes that the whole terrestrial globe fell to pieces and was dissolved by the waters of the flood, and that the strata of the Earth fell down from this promiscuous mass; he further insisted that marine bodies, as shells, are lodged in the strata according to the order of gravity, the heavier shells in stone and the lighter ones in chalk, and so of the rest.

Whiston endeavored to prove that the Earth was originally a comet, which being modified or remodelled was brought into its present shape. The great heat which the Earth retained, owing to its igneous origin, inflamed the passions of the whole antediluvian race, so that every imagination of the thoughts

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of man's heart was evil continually. The awful catastrophe which swept this wicked race, with the exception of Noah and his family, from the face of the Earth, was occasioned by the train of a comet, which passing near the Earth, was condensed upon it in the form of a deluge of waters.

Kepler supposed, or pretended to suppose, that the Earth contained a circulating vital fluid, and was possessed of living powers, and that a process of assimilation goes on in it as well as in other animals. Every particle of matter, according to him, is alive, and possesses volition and instinct; hence these particles attract and repel each other according to their several sympathies or antipathies. Thus the particles of water will repel those of oil because they have an antipathy to each other, but each fluid will readily unite with another portion of the same kind, because the particles possess mutual sympathies. Burning mountains are the respiratory organs of the globe, and the slates are the organs of secretion, as the glands are those of the animal. The slates decompose the waters of the ocean in order to prepare its elements to produce earthquakes and volcanic eruptions. The metalic veins in the strata of the Earth are caries or abscesses of the mineral kingdom, and the metals themselves are the products of decay and disease, and hence the offensive odor of some of these products.

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The two prevailing theories were the Plutonian and Neptunian; the former attributes most of the present appearances of the globe, and the changes it has undergone, to the agency of fire, not entirely rejecting that of water, while the latter on the contrary affect to prove in as positive terms, that these same changes and appearances may, with the exception of volcanic products, be traced entirely to the agency of water, to aqueous solution, disintegration, and deposition.

It may be well to mention some of the causes which have been and are now operating to change the surface and appearance of the Earth.

"If we attribute the elevation of mountains to subterranean fire, and the excavations of the great valleys to floods of water, it is evident that these causes must have been more powerful at some remote period than at present."

GENERAL EFFECTS OF RUNNING WATER.—It is well known that mountains or land elevated far above the level of the sea, attract the moisture of the atmosphere in proportion to their elevation. Thus the higher regions of the Earth become perpetual reservoirs of water, which descend and irrigate the plains and valleys below. A great proportion of the water which falls upon the Earth is carried first to the higher regions, and then made to descend, often by steep declivities towards the sea, so that it acquires a rapid velocity,

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and removes a greater quantity of soil than it would do if the rain was equally distributed on the mountains and plains. Thus, without reference to the disintegration, or decay of rocks, the water constantly transports more or less soil and gravel from the hills to the plains.

Rapid streams charged with foreign matter and thrown against the banks, will in the course of time produce excavations, in consequence of which rocks are often undermined and thrown into their beds. The water being thus obstructed accumulates, and cuts for itself a new channel, taking with it an additional quantity of earth. In this manner, also, the stream is often made to take a new direction, perhaps obliquely, across the valley through which it runs.

"The river Po affords a grand example of the manner in which a great and rapid stream bears down to the sea the alluvial matter poured into it by a multitude of tributaries, descending from lofty chains of mountains. The changes produced by this river in the great plains of Northern Italy have been exceedingly disastrous to some parts of that country. Extensive lakes and marshes have been slowly filled up, while others have been drained by the same cause. The town of Bressello, which formerly stood on the left bank of the river, now stands on the right, the river, not the town, having changed its locality. To keep this wild

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stream within bounds, a general system of embankment through the plains of Northern Italy was commenced in the 13th century, which has continually been increased until the present time. The increased velocity of the river in consequence of its being thus confined, causes it to transport to the sea a much greater quantity of alluvial matter than it would otherwise do, because there are no sluggish intervals where its waters can deposit their sediment. Hence the delta of the Po, within the memory of man, has greatly increased. The ancient city of Adria, was originally a seaport of the Adriatic, but now it is twenty miles from the shore."

THE FALLS OF NIAGARA.—"The river, on flowing out of Lake Erie, is almost on a level with its banks, so that should it have a perpendicular rise of eight or ten feet it would overflow the flat country of Upper Canada on the west, and a part of New-York on the east."

There is no doubt but that the Falls of Niagara, at some remote period, were at Queenstown, which is about seven miles below their present situation. The gorge or excavation made by the waters is on approaching the falls about 12,000 feet broad, but is much narrower towards Queenstown. The kind of rock through which it passes consists of limestone and shale, the latter a dark colored shelly formation, eighty

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feet thick, lying under the limestone. The limestone is seventy feet thick, upon which rests the ordinary soil of the country. The limestone is hard, and lies in horizontal strata at the edge of the falls, but the shale is soft, and is acted upon with much greater facility than the limestone, so that the latter rock often overhangs the former, perhaps forty feet at the edge of the precipice. The blasts of wind charged with spray, which rise out of the pool into which this enormous cascade is projected, strike against the shale beds, so that their disintegration is constant; and the superincumbent projecting limestone being left without a foundation, falls from time to time, in immense rocky masses. When these enormous fragments fall, a shock is felt often at considerable distances, accompanied by a noise resembling a clap of distant thunder. Should the water by any ordinary course or by some convulsions of nature find a passage through under the superincumbent limestone, a tremendous deluge would ensue.

The mechanical action of water in cold climates is very great. It is a well authenticated fact that water expands by freezing. The effect of this expansion is sufficiently powerful to burst bomb shells and even large cannon when confined in them. When water falls into the fissures of rocks and then freezes, the rocks are rent apart with tremendous force, and the

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porous ones are divided into small pieces. These are often further divided by the fall, and consequent crushing and grinding motion of one rock upon another, on the declivities of the mountains. Water, also, has the power of dissolving some kinds of rock, as lime and gypseous rocks. The oxygen of the air is another cause of the decay of rocks. It is absorbed by many of the rocks, with which it unites and destroys the affinity of the other substances, consequently effects a dissolution of the rocks.

DELTAS.—The deposition of earthy matter at the mouth of rivers where they enter into lakes or seas, have, and are producing considerable changes in the surface of the earth. The quantity of matter which rivers carry down depends chiefly upon the rapidity of the stream, and its liability to overflow its banks. So great has been the quantity of matter deposited at the mouths of many rivers, that dry land has been formed and cities built on places which had long been covered by a considerable depth of water.

BATHS OF SAN VIGNONE.—"This spring, in Tuscany, affords a striking example of the rapid precipitation of corbonate of lime from thermal waters. This issues from near the summit of a hill one hundred feet high. The water is hot;" but Mr. Lyell, from whom this account is taken, does not give its temperature. "So rapid is the deposition from this water, that a

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pipe leading from the spring to the baths, and inclined at an angle of thirty degrees, is found to contain a coat of solid limestone a half a foot thick every year. A mass of solid rock below the hill, formed by this water is two hundred feet thick."

SILICEOUS SPRINGS.—Although there is no chemical process by which water may be made to dissolve pure silex, or flint, yet in the great labaratory of nature this effect is produced. There is, however, a process in chemistry which, by a previous combination, silex becomes soluble in water, and which perhaps affords an analogy to the process employed by nature. If silex be finely pulverized, and then melted with a quantity of common alkali, the whole becomes soluble in hot water. Springs containing any considerable quantity of silex are always of high temperatures, and it is to the great degree of heat which exists at their sources, together with small portions of alkali which volcanic rocks contain, and which the water dissolves, that we are to attribute the property these waters possess of holding silex in solution. Springs containing considerable quantities of silex are exceedingly rare, and are mentioned rather on this account than for the changes they have produced on the Earth's surface.

MOUNTAIN SLIDES.—Instances have happened in various parts of the world where considerable changes

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have been produced on the surface of the globe by the sliding of large portions of earth, together with fragments of rocks, from the declivities of mountains; such for instance as the slide of the *White Mountains*.

DESTROYING EFFECTS OF THE SEA.—Mr. Lyell has adduced many instances of the power of sea waves to move large masses of solid rock. "The village of Mathers, on the east coast of Scotland, was destroyed by an inroad of the sea in 1795. This town was guarded by a barrier of limestone rock next the shore, but during a storm the waves of the ocean broke through the barrier, and in one night destroyed and swept away the whole village. The sea penetrated one hundred and fifty yards inland, where it has maintained its ground ever since. If such is the immense power of a sea wave when thrown with velocity against the shore, who will be at a loss to comprehend why the strongest ships are reduced to fragments in a few minutes, nor will he wonder at the destroying effects which a wide ocean must produce on a coast not guarded by a strong barrier of solid rocks."

DOWNS OR SAND HILLS.—"In some sections of country, the fine sand that is thrown up by the sea is carried by the wind considerable distances and in such quantities as to cover the land entirely and to fill up lakes and estuaries. Occasionally, also, there are sand plains at a distance from the sea, where vegetation seems

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never to have taken root, where consequently there is nothing to prevent the sand from spreading in all directions by the force of the winds.

Snow line.—The sketch illustrating the distribution of permanent snow on the Earth's surface, shows the effects of latitude upon the temperature, and the influence of height in the production of cold. Thus the limit of perpetual snow over the globe is bounded approximately by a spheroidical surface flatter than the terrestrial spheroid, and cutting it in the vicinity of the poles. The portion of the Earth's surface under perpetual snow has never yet, we believe, been estimated. The most conspicuous masses next the antartic regions are the Cordillera, the Himalaya range, the Altai, and Ural, and the Alps; but from the steepness of most elevated summits and absolute want of *very* elevated table lands, the area they present is inconsiderable. From the variable elevation of the snow line, the snow-clad portions of mountains are very disproportionate to their height in different latitudes. Chimborazo in Peru rises only 5600 feet above the snow line; whilst Mont Blanc, in Europe, which is 6000 feet less in height, is covered with snow for the upper 7000 feet of its elevation. The height of the snow line depends materially on the extent of snow-clad surface rising above it, an extensive snow-capped chain of mountains lowering the level of perpetual

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snow, whilst an isolated summit may rise above the level of the theoretical snow line, without retaining the snow for the whole year.

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CLASSIFICATION OF ROCKS.

A variety of classifications have been adopted by different geologists, some of which are too prolix and complicated for a popular work, while others are forbidding, on account of the technical language in which they are written. Perhaps the best which we can adopt, as embracing all the others, without their minute subdivisions, is the following:—

1st. Plutonic Rocks.
2d. Metamorphic.
3d. Paleozoic, comprising:
    a. The Older Paleozoic.
    b. The Newer Paleozoic.
4th. Secondary, comprising:
    a. Older Secondary.
    b. Newer Secondary.
5th. Tertiary.
6th. Volcanic.

PLUTONIC ROCKS.

These rocks, which appear to be produced by the action of fire, constitute the great frame or ground work of the globe. They form the lofty mountains, and at the same time extend downward below all other formations; they are not

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arranged regularly in superposed beds, nor do they contain the remains of organized bodies. One of the principal rocks of this class is Granite. This rock is composed of quartz, felspar, and mica. Quartz, composed principally of silex, has commonly a glassy lustre, an opaque white color, and not unfrequently smoky, gray or brown; these are its usual appearances, though it occurs yellow, pale or deep pink, and approaching to red. It is hard, and will scratch glass. Its composition is granular and strongly adherent. The more beautiful varieties occur crystalized in six and twelve-sided prisms. Felspar is composed of silica, alumina, and potash, with traces of lime, and often of oxyd of iron. It has a yellowish or a milk-white color, and when broken often divides into layers of considerable thickness with smooth shining faces. Mica is also sometimes white, but more commonly of a dark green color. It consists of thin flexible leaves adhering slightly together. It is well known under the name of isinglass, and when in large plates it is used for the dead lights of ships, windows, stoves, &c. Granite never consists of strata or layers, like gneiss and mica-slate. There are several varieties of granite, some of which are composed of crystals or grains a foot in diameter, while in the other the grains are no larger than those of sand. The color of the small-grained granite is generally gray, although sometimes reddish, owing to the color of the felspar which predominates. It is extremely hard, and is employed in

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the construction of edifices where strength and durability are required; certain kinds of it remain for centuries exposed to the inclemencies of the weather without undergoing any alteration, while others are speedily reduced by the action of the atmosphere to a species of grit or argillaceous earth. It is found in almost all parts of the world, presenting all the characters of a rock of igneous origin. When the minerals are so arranged in this rock as to resemble lines in Arabic writing, it is then called *Graphic Granite.*

SYENITE is a granitic rock consisting of quartz, felspar and hornblende. It is of a gray or dark green color, and sometimes it has a dull red appearance. It is often mistaken for granite although tougher, and a more durable building stone.

PRIMITIVE LIMESTONE is both granular and crystaline in its structure, and is found associated with granite and gneiss, often alternating in layers with the latter. All calcarous rocks will effervesce when strong acid is applied to the surface, and they dissolve entirely in nitric or muriatic acid. This action of the acids distinguishes limestones fromall other minerals. The color of Primary limestone is sometimes yellowish, greenish, or inclining to red. When beds of Primary Limestone occur of considerable thickness they sometimes contain veins of metallic ores.

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METAMORPHIC ROCKS.

This division of rocks is devoid of sand or pebbles, and no organic bodies have been found in them, yet they are divided into beds arranged in form like those of sedimentary formations. It is the probable opinion that the materials of the strata were originally deposited from water in the form of sediment, and afterwards changed by subterranean heat, so as to assume a new texture.

Gneiss is composed of the same materials as granite, but it contains more mica, and the grains are much smaller than granite. In Gneiss the quartz and felspar are closely aggregated together in strata, between which intervene scales of mica. In consequence of this structure, the rock easily splits in slabs along the planes of mica. It is usually a stratified rock used for building and flagging.

Mica Slate is chiefly composed of quartz and mica, felspar being found in very small quantities. The quartz is commonly in fine grains, and the mica usually predominates, or at least is much the most apparent. Some specimens of this rock appear to be almost entirely composed of small scales of mica closely adhering together. Mica slate has often an undulating and curved structure; it is abundant and frequently has garnets and precious stones imbedded in it. It is readily divided into layers or tables by means of wedges, and is extensively used for flagging the sidewalks of cities.

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HORNBLENDE SLATE is a mineral of a dark green or black color, containing oxyd of iron, and entering into the composition of several other rocks. Hornblende is a constituent of gneiss and sienite, and is sometimes found in granite. It may be known from mica on being scraped with a knife, when a dull green powder will be produced.

QUARTZ appears in forms both massive and aggregate, regular and irregular. When the texture is made up of distinct grains, it is usually denominated *granular quartz*. See Quartz, one of the constituents of granite.

TALCOSE SLATE is a magnesian structure, occupying a position among the Metamorphic rocks. Talc in a pure state is found in crystals more than a foot square. When found in this state they are used in some countries as a substitute for glass. Another variety, which is unctuous to the feel, is used for tracing lines upon wood, cloth, etc., which are not so easily effaced as chalk. The color has various shades of green, from pale to very dark. Very thin particles are translucent with a pearly lustre.

PALEOZOIC ROCKS.

These formations are thus named because they contain ancient animal remains, "they do not appear to have begun to form, until the first had been disturbed by some great geological convulsions." The strata of which these rocks are composed appear to have been formed by a slow and continuous deposit of sand, mud, and other

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materials suspended in water. They are divided into Older and Newer.

TACONIC SYSTEM.

The Taconic System comprises a series of sedimentary rocks, which compose or form that part of the Green mountains which was formerly known as the Taconic range. The rocks themselves consist lithologically of Sandstones, Limestones and Slates, the lower portion of which, as the sandstones and limestones, were often spoken of as metamorphic rocks. The grounds upon which this system has been proposed, are first, position, being inferior to the New York system on the one hand, and superior to the primary on the other. The inferior members of the New York system, as the Calciferous and sometimes Potsdam sandstone, rest upon the slates of the Taconic system unconformably, and so also the inferior members of the Taconic system, as the brown sandstone or granular quartz rests on the primary of the Green mountain range. The order of succession proves the independence of the Taconic system. Further evidence is also furnished in the organic remains of the slates. The system, geographically, lies between the Hudson river on the west, and the Hoosic mountains on the east, extending rather north-easterly and south-westerly through the United States.

Sandstone consists chiefly of sand cemented together in a solid form. It sometimes contains pebbles worn by the agency of water, together

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with angular pieces of granite, slate and quartz, having the appearance of being made of the ruins of former rocks. Owing to the oxide of iron it contains, which seems as a cement to the grains of sand, its color is commonly red. Sandstone affords a great number of varieties, which alternate each other by insensible changes or degrees. It is widely dispersed and used for various architectural purposes.

SLATE.—This rock is more distinctly stratified than all others, being divided into thin plates, and its strata are sometimes highly inclined, being nearly vertical. Its appearance is too well known to need description.

LIMESTONE.—This is an abundant rock, composed of a carbonate of lime, and it is employed in making quick-lime for mortar, and also in many countries as a building stone. Many of the common variegated marbles belong to this formation. The three foregoing rocks, Sandstone, Limestone and Slate, do not belong to any era in particular, but occur in several distinct periods, being characterized in each instance by peculiar fossils.

NEW YORK SILURIAN SYSTEM.

"The divisions established by Mr. Murchison for the Silurian system of Wales, are readily recognized in New York; showing that the same order of different kinds of fossils follow each other in the two countries, leaving no doubt on the mind, of general causes having operated in the two coun-

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tries in the same order of succession, showing a distinct fossil character for each division; and not in these two countries only, but in others more widely remote, the same series, in the same order, existing in northern Russia, as ascertained on examination by the same distinguished geologist." The New York, or Silurian system, is composed lithologically of sandstones, conglomerates, slates, shales and limestones. Its members may be arranged in groups more or less characterized by their fossils. These members or groups are all conformable with each other, a fact, which shows, that during the silurian period, no disturbances occurred, of sufficient magnitude to interrupt the regular deposition of its strata. The several members of this system, are indicated upon the chart, together with some of the fossils which characterize them. The locality from which the name of the rock is taken exhibits the best development of the rock with its characteristic fossils.

POTSDAM SANDSTONE is commonly of a quartzose structure, of a grey or reddish color, and sometimes striped. It often assumes a slaty appearance probably from its proximity to rocks of igneous origin. This rock is quite extensive, being known in New York, Canada, Pennsylvania, New Jersey and on Lake Superior. This is the lowest rock in which moluscous animals have been found. The fossil peculiar to this rock is a species of lingula, being found in each group of the system, and yet exists in the ocean.

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CALCIFEROUS SANDROCK, is an intermixture of sandstone and limestone equally as extensive as the rock below it. Indurated bitumen occurs in this rock, in small quantities, associated with quartz. The fossils found in it are not numerous, their names and number may be ascertained by reference to the appendix. X

BLACK RIVER LIMESTONE consists of the Birdseye and Chazy limestone. The Birdseye limestone of Prof. Eaton, is often of a light dove color, which, on exposure, becomes light ash-grey, and may be distinguished by its peculiar fossil the *Fucoides demissus*. Dr. Emmons is of the opinion that the Chazy limestone is a distinct rock, containing a few fossils of a distinguishing character. The rock appears in the northern part of New York, Pennsylvania, Kentucky, Virginia, and along the Mississippi.

TRENTON LIMESTONE.—Of this rock there are two distinct varieties. The first is a dark colored, fine grained limestone, in thin layers, separated by black shale or slate. The second is a grey, coarse grained limestone, in thick layers, which forms the top of the mass; the grey part is quite crystaline. The Trenton limestone is well characterized by fossils, some of which are peculiar to this rock. The metals are lead and zinc ores, but neither are found in profitable abundance. It extends uninterruptedly from East Canada creek to the St. Lawrence river, appearing equally extensive with the rock below it.

UTICA SLATE.—This rock is of a deep bluish

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black, generally fossiliferous, exhibiting a brownish or dark chocolate color by alteration or long exposure to the weather, producing, by decomposition, a tenacious, clayey and highly favorable soil for grass, forming dairy land of the best quality. The beds are from one to five inches in thickness, and often present veins of white lamellar carbonate of lime. This rock contains some sulphuret of lead associated with pyrites.

Hudson River Group.—When the strata have not been disturbed this group is not easily distinguished from the Utica slate. The group consists of shales and shaly sandstone with thin courses of limestone; in many places its upper portions abound in fossils. The extent of this group seems to be equal to any of the masses below, and its lithological character changes with different localities. It extends not only into Canada but appears in Pennsylvania, Virginia, Tennessee, and Arkansas.

Grey Sandstone.—This rock consists of grey sandstone with a greenish tint of dark blue and greenish shale. It is not in very thick or regular layers, but is fine grained with little or no tendency to decomposition, consequently makes a durable material for building purposes. The grey sandstone succeeds the Hudson river group in Oswego county, there being a gradual passage from one to the other. The fossils are a few fucoids, and numerous bivalve shells.

Medina Sandstone.— This rock succeeds to the grey sandstone. The line of demarkation may,

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in some instances, be indistinct between them. This sandstone is generally of a brown-red color, being both fine and coarse grained, the latter of the deepest color, the former more variegated. The oxide of iron forms its red coloring matter, appearing to have been transfused through its material, penetrating as far as its particles could gain admittance. The red sandstone is the lowest of the New York series, which contain brine springs of sufficient purity and quantity to manufacture into salt. The springs are quite numerous, being found from the eastern part of Oswego to Niagara river. At Medina, shells of lingula, pleurotomaria and cytherina, occur in abundance.

Oneida Conglomerate is composed of quartz pebbles, rarely exceeding three-fourths of an inch in diameter, and of white or yellowish quartz sand. Its greatest thickness is in Oneida, yet it is supposed to be of still greater thickness in the Blue ridge of New Jersey and Pennsylvania, from which its materials are drawn. The conglomerate is a part of the Clinton group, the next mass in the order of superposition.

Clinton Group.—This group consists of green and black-blue shale, greenish and grey sandstone, red sandstone laminated, calcareous sandstone, encrinal sandstone, and red fossiliferous iron ore beds. This group is well characterized by its various ore beds and marine plants, both in New York and Pennsylvania. The most persistent member of this group is shale. The next member is green sandstone, this is in thin layers,

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and the surface is generally covered with fucoids. The third is the iron ore beds, of which there are two; the other masses, though some of them are thick, yet they are to be found in few towns. Near New Hartford, at Reed's mills, two beds of iron ore appear about twenty feet from each other. This group contains sulphate of baryta and crystalized carbonate of lime.

NIAGARA GROUP.—This group consists of limestone of a dark-blue or black color, and of dark shale or slate. This group is very thick in some localities and forms the rocks of Niagara falls. The position of the Niagara group is well defined, being south of the Clinton group, upon which it rests, and north of the Onondaga salt group, which overlies it. The limestone of this group present several varieties, some of which are contorted and concretionary like the coats of an onion; others form a hydraulic cement when used for that purpose. The fossils peculiar to the limestone of this group, are encrinites, the mineral, iron pyrites, dogtooth spar, selenite, celestine, zinc blende and galena.

ONONDAGA SALT GROUP.—This is decidedly the most important group of the state, containing not only all the gypsum masses of western New York, but all the salt water salines of Onondaga and Cayuga counties. This group extends through the third and fourth districts into Canada. This group has been divided into four deposites though there are no well defined lines between them. The lowest deposite is red shale with green spots

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in the upper part of the mass. The second is gypseous shale, the lower part alternating with red shale, which ceases with the mass. The third is the gypsum deposit, which embraces the great masses quarried for plaster, consisting of two ranges, between which are the hopper-shaped cavities, and other porous rocks. Those rocks which show needle-shaped cavities placed side by side, caused probably by the crystalization of sulphate of magnesia, which, from that circumstance, have been called the magnesian deposite. All of the deposites are found between Oneida creek and Cayuga lake; to the east of the creek they do not occur. The characteristic fossil is the Eurypterus remipes.

WATER LIMESTONE.—This group takes its name from the character of the rock from which water lime is manufactured. It consists generally of dark-blue limestone, and usually of two layers of dark colored or water limestone, the two are always separated by an intervening mass of blue. The group is well defined and readily recognized, both in New York and Pennsylvania, by its mineral character, its fossils and position. It extends through the third district of New York, having a thickness of not less than thirty feet, and often extending to more than a hundred.

PENTAMERUS LIMESTONE.—This rock takes its name from the fossil, Pentamerus galeatus, or galeated pentamerus. This fossil abounds in the rock and is principally confined to it. The Pentamerous limestone enters from the first district

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of New York with considerable thickness, and continues to the falls of Oneida creek, beyond which it has not been distinctly recognized. It is usually of a black-grey color, in grain crystaline, rarely found pure, being mixed more or less with black shale, which gives a dark color to the rock. The Petamerus limestone is burnt for lime in several places along its range.

Delthyris Shaly Limestone.—This mass is of great interest as it respects fossils. The lower part of it is usually a mixture of dark bluish-grey shale, which changes to a dark ash color on exposure, and of a fine grained, blue limestone. The upper part, at the Catskill creek and the Helderberg, is a light-grey, coarse, crystaline limestone, which abound in fossils, and appear to be parts of an encrinite. The best development of this rock is found in the first district of New York; the shale disappears in Herkimer county, but the limestone portion continues to the east end of Madison county, beyond which it has no existence. The Big-ribbed Delthyris is abundant in the first district, so also the Thick-winged Delthyris, whence the name of the rock is derived. The same class of fossils occur also in Pennsylvania.

Encrinal Limestone contains abundance of a flat or saucer-shaped pelvis of a crinoid, and other broken remains of crinoidea, in a crystaline condition. This rock appears best developed in Schoharie and the Helderberg; it continues as far as Lake Erie.

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UPPER PENTAMERUS LIMESTONE.—This rock rests upon the encrinal limestone. According to the opinions of Mr. Gebhard, it is distinguished from any other rock by its peculiar fossils, among which is a species of pentamerus, shaped like the Pentamerus galeatus, but quite smooth, and evidently a distinct species.

ORISKANY SANDSTONE is a coarse, sileceous sandstone, of a yellowish-white color. It contains some flattened nodules of flint. The Oriskany sandstone appears to be deposited in depressions, formed, either from the inequalities of previous rocks, or from denudation. The characteristic feature of this rock, is the abundance of small cavities, formed probably by the destruction of fossils. This rock occurs in Pennsylvania, being an important formation, from three hundred to seven hundred feet in thickness, while in New York it is not above thirty.

CAUDA GALLI OR COCKTAIL GRIT, receives its name from its mineral character, and from the feathery forms that appear in it. It is a fine grained calcareous, and argillaceous sandstone, usually of a drab or brownish color. It strongly contrasts with its associate rocks, by reason of the singular impressions which it contains, some of which, and parts of all, greatly resemble the curling feathers of the male of the common barnyard fowl. The size of the forms, vary from four inches to a foot in diameter. The feathery forms are usually numerous in all its localities. This rock appears in the first district of New York,

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and extends westward; it is also found in New Jersey with the same impressions, and equally abundant.

Schoharie Grit.—This is a fine grained siliceous limestone, or calcareous sandstone, the calcareous matter of which disappears when exposed, leaving a siliceous rock of brown color. It contains a species of Pleurorhyncus orthoceras, and numerous forms of corals. It is well developed at Schoharie, and in the Helderberg, but does not extend far westward.

Onondaga Limestone has a crystaline structure and a light grey color, with numerous organic remains, smooth encrinal stems about an inch in diameter. The layers of this rock, as is usual with limestone, are separated by a small amount of greenish shale. It extends from the Helderberg to near Lake Erie, and is considered one of the most valuable stones of the Helderberg series, being quarried near Syracuse for the construction of the canal, and more or less used as a marble.

Corniferous Limestone, is a name given by Prof. Eaton, to a rock which contains flint or hornstone in nodules, in one or two layers, throughout the whole extent of its range. The nodules are arranged in parallel layers. In the corniferous limestone, there are fossils by which it may readily be distinguished from other rocks, though the individuals are few, and not found in every locality. One of the characteristic fossils is the Dontocephalus selenurus. Under this head is included the Seneca limestone, of which the

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limited space of this work, precludes a particular description.

MARCELLUS SHALE.—These shales extend from the Hudson river to Lake Erie. They are divided into two masses, on account of the presence of limestone and fossils in the one, and their absence generally in the other. The limestone is very impure; of the same dark color of the shale; rarely forming continuous layers, but interrupted, flattened masses, with slate or shale interposed. The characteristic fossils are the goniatite and limitary orthis.

HAMILTON GROUP.—This group includes the masses between the Marcellus shales, and the Tully limestone. In thickness it varies from three hundred to seven hundred feet, extending from near the Hudson river, to Lake Erie; it is therefore important, both on account of its thickness, and the extent of surface it occupies in New York. It consists of shale, slate, and sandstone, with an endless mixture of their materials. The first is a fine grained shale, of a dark-blue color; the second a coarse shale, often mixed with carbonate of lime, of a dark-grey color; the third is a well characterized sandstone, more or less mixed with the two others. In organic remains, it is the most prolific of all the New York rocks.

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DEVONIAN SYSTEM.

The upper New York rocks, which form the superior part of the preceding formation, are considered equivalent to the Devonian system, so largely developed in Devonshire, England, and which is composed of slates, limestone and sandstone, differently developed in different countries. Mr. Conrad was the first American geologist who perceived the equivalency of the upper New York rocks, to those which were described by Mr. Philips, under the name of Devonian; but it is not proved that the two are identified. This much, however, seems to be established, namely: that the rocks of the two continents, limited upwards by the coal series, and by the Taconic system below, were deposited during the same period; but whatever of a modifying nature existed in either continent, had its influences on each series respectively. Organic beings were formed on the same types in the two countries, but rarely identical. The study of fossils has given us power to compare our rocks with others at distant points, and to establish our system on a basis which is truly American, and which has really created an American geology. Our Silurian and Devonian systems are sufficiently well defined to answer all the ends of science.

Tully Limestone.—This is a black, fine grained, compact limestone. In Albany and Schoharie counties it is unknown, neither does it appear west of the Genesee valley, it is exposed

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upon the western shore of Cayuga lake, on the eastern shore of Seneca lake, at Bellona, in Ontario county, and at the outlet of Crooked lake. Carbonate of iron appears in this rock in minute veins, and fossils peculiar to the Devonian system, namely, the Cuboidal atrypa, and the Tully orthis.

Genesee Slate is usually a black slaty structure, but often stained brown upon the outside by decomposing pyrites. Its laminæ separate easily and fall to thin pieces of the size of a penny; forming by this kind of disintegration, a flat gravel. The whole mass is bituminous, the fossils are peculiar but few in species. The localities most favorable for observing the Genesee slate, are the great gorge above Mount Morris, Cayuga lake, south of Ludlowville, the falls of Lodi, and the outlet of Crooked lake.

Portage Group is mainly a grey, fine grained sandstone, and so gradual has it changed from a thin, black slate, to a thick bedded sandstone, that it is useless to attempt to draw a division line between the upper and lower strata.

Chemung Group.—This group is made up of flags and slates, whose beds are thinner than those of the Portage group, upon which they rest. The flags are grey-olive and brown, with impure calcareous bands of fossils. The shales are green and olive, but sometimes black. The stratification is usually distinct; in the upper part it is diagonal, a fact which may be used for determining the position of this mass at distant points. Carbonate of lime often replaces its fossils, particularly its

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encrinites, which are usually about half an inch in diameter, and different from those of any rock below it.

Old Red Sandstone.—The name would lead to the inference that it is a red rock mainly, whereas only about one third of it is red, the rest being a dark slate or greenish or greyish flagstone. This group (denominated the Katskill group of the New York series) consists of light colored greenish-grey sandstone, usually hard, of fine grained, red sandstone, red shale or slate, of dark colored shale or slate, and of grindstone grit. The fossils which have been observed in this group in this state so far, are very few; so also in Pennsylvania, where the mass has considerable surface, distribution and great thickness. The Catskill group is the immediate predecessor and base of the coal formation. In this group, both in England and Pennsylvania, are the remains of a peculiar class of fish, which shows the value of the fossil character, since the position of this rock is well established, holding the base of the coal in both countries, and the upper member of the Devonian system.

CARBONIFEROUS SYSTEM.

The Carboniferous System is intended to embrace all those deposites which are supposed to belong to that era, in which the coal fields were produced. After the revolutions which seem to have terminated the period in which the preceding deposits were formed, the Earth appears to

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have remained in a state of repose, and new generations of organized beings were permitted to multiply on its surface, and mineral substances were carried by the water, to be deposited in layers to entomb in their substance, the solid remains of exuviæ of cotemporaneous animals and plants.

Carboniferous Limestone.—This rock takes its name probably, from its proximity to the coal measures; it is irregularly stratified, moderately hard and compact, rarely granular or crystalized, being commonly of a black or bluish-grey color, and sometimes variegated. It forms lofty mountains and deep ravines, exhibiting evident signs of having been disturbed by some cause, which has thrown the Earth into great confusion, by which numerous metalic veins are exposed. It contains a great number of organic remains; the prevailing characteristic fossils are encrinites, and madrepores, together with a few species of mollusk's, as the Orthoceras lateralis and the Goniatites evolutus.

Conglomerate.—This rock is commonly composed of pebbles and coarse sand, cemented by a calcareous, siliceous, or argillaceous substance, holding the same relation to the coal measures of the United States, that the millstone grit does to those of England. The deposites of coal in France, begin with pudding stone, formed from the debris of the different rocks from the surrounding country, alternating with the sandstone more or less fine, according to the grains of quartz

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and quantity of argillaceous matter which enters into its composition.

Coal.—This well known substance affords several varieties, differing in color from dark brown to jet black, containing variable proportions of carbon and bitumen, with more or less impurities. Black or common coal is composed of carbon, bitumen, and earthy matter. The proportion of earthy matter in different coals, varies from two to twenty per cent; that of bitumen from twenty to forty per cent, and the carbon from forty to eighty per cent, or even ninety per cent.

Anthracite Coal.—A variety of coal almost wholly deprived of bitumen. It may more properly be regarded as a natural charcoal, formed by chemical or subterranean heat. Common bituminous coal is often found converted into anthracite by effusions of igneous rock; and this fact suggests the idea, that all deposites of this kind have been similarly produced. The most extensive fields of anthracite are found in Pennsylvania and the bordering states. This mineral is distinguished from bituminous coal by its greater lustre and weight, by its hardness and conchoidal fracture, and by its burning with little smoke, or blaze, or bituminous odor. Coal is found in regular strata or beds, from a few inches to several yards in thickness. Several beds commonly lie under each other, being separated by strata of slate, fire clay, and stone, and not unfrequently by iron stone.

These strata are called Coal Fields or Coal

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MEASURES. The coal fields of the United States are numerous and extensive. Coal is found in Massachusetts, Rhode Island, Pennsylvania, Illinois, Alabama, Mississippi, and Indiana. The coal formation of the United States is greater than in any country or kingdom on the face of the Earth, and embraces every variety which has ever been discovered. Coal is formed of vegetables. At the period of the COAL FORMATION, the Earth appears to have been occupied in a great part by a deep sea, studded with islands covered by an abundant and luxurious vegetation, embracing species of plants and trees differing much from those now living.

Coal in the Southern and Middle States is found connected with large quantities of valuable iron ore. The coal obtained from the Pennsylvania mines, has been improperly called ANTHRACITE coal, because it emits but little smoke in burning, but is only a variety of common coal containing a small quantity of bitumen. Anthracite is a mineral nearly like plumbago or graphite; it consists nearly of pure carbon, is extremely hard and difficult to ignite, and has often a semi-metalic lustre. It occurs in rocks which have been more or less altered, and sometimes in small quantities in regular coal strata.

In regard to the origin of coal, there have been almost as many different opinions as geologists. Some believe that the luxuriant vegetation which covered the Earth at that period was repeatedly submerged by the sea, and elevated again by some

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being again covered with vegetation, submerged and elevated for each succeeding strata; thus continuing the process of submergence and elevation as often as there are beds of coal in any particular coal field.

The other theory is, that while partial elevations and submersions might take place as at the present day, the great mass of the coal measures was deposited in lakes and estuaries; that the vegetable matter of which coal is formed was drifted into these estuaries by rivérs and inundations; and that various rivers might discharge themselves into one estuary, some chiefly carrying down sand, while others transported plants, mud, and heterogeneous matter. This theory also supposes that the transporting rivers were subject to periodical inundations, and that, during the intervals of overflow, the deltas were choked with a rank vegetation, which, in conjunction with the vegetable drift from inland, went to the formation of beds of coal.

PERMIAN SYSTEM.

After the luxuriant vegetation which adorned the surface of the earth during the coal period had been either destroyed or converted into coal by the geological convulsion which separated this epoch from the succeeding, this convulsion seems to have been followed by extensive deposites of calcareous and sandy matters. The Permian System is limited below by the coal region and upwards by the triassic division,

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embracing that series which usually succeed the coal formations of Europe. For illustration see chart.

MAGNESIAN LIMESTONE is a rock composed of carbonate of lime and carbonate of magnesia. The color is seldom pure white, except the compound granular varieties, but generally inclines to red or green. It is sometimes finely laminated, at other times granular and crystaline; in this state it is called Dolomite. Extensive series of beds begin above the coal measures. Dolomite occurs abundantly in nature; it enters extensively into rock formations, and frequently prevails over extensive districts of country. It is easily mistaken for a granular variety of rhombohedral lime. In the Magnesian Limestone are found fossil fishes, of the genera palœoniscus, similar to those of the coal measures, but they are not found in any formation subsequent to the one we are now considering.

LOWER NEW RED SANDSTONE.—This is a deposit of fine granular sand, usually red, but sometimes brown or yellowish. It contains few organic remains, and is worthless so far as metalic products are concerned.

THE TRIAS OR TRIASSIC SYSTEM

Comprehends within its limits upper new red sandstone, muschelkalk, and keuper. This group abounds inremains of shells, fragments of radiated animals, encrinites, fishes, and several species of large saurian reptiles.

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Upper New Red Sandstone.—This is a fine grained, solid sandstone, commonly red, but sometimes of a blue or greenish tint. The structure of the lower part is sufficiently fine grained and compact to form a good building stone, but the uppermost is incoherent and passes into an earthy clay containing gypsum. It contains numerous remains of fossil plants and some marine shells which are confined to particular localities. In this series are found foot-prints, some of which evidently belonged to birds, and others are supposed to belong to marsupial mammals or reptiles. This rock is often known under the names of Bunter Sandstein and Gres Bigarré.

Muschelkalk, or Shell Limestone is a compact limestone, of a grey or greenish-grey color, and commonly contains in great abundance the remains of shells and fragments of radiated animals and fishes. Sometimes it is a bituminous rock, and emits a fetid, disagreeable odor when rubbed or struck with a hammer. Among the characteristic shells are the Ammonites nodosus. Encrinites also abound, of the species moniliformis.

Keuper forms the uppermost division of the Triassic system. This group usually consists of a numerous series of mottled marls, of a red, greenish-grey, or blue color, which pass into green marls, black, slaty clays, and fine grained sandstones. Throughout the series common rock salt and gypsum are abundant. Vegetable

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remains of the genus wilsonia and pteraphyllum occur in the Keuper.

SECONDARY ROCKS.

The secondary strata are composed of extensive beds of sand and sandstone, mixed occasionally with pebbles and alternating with deposites of clay, marl, and limestone. The materials of most of these strata appear to have been derived from the detritus of older rocks; the larger fragments often indicate the sources from which they were supplied.

The transport of these materials from the site of older formations to their place in the secondary series, and their disposition in strata widely extended over the bottom of the early seas, seem to have resulted from forces producing the destruction of more ancient land on a scale of magnitude unexampled among the actual phenomena of moving waters. These rocks have been divided into the Older and Newer Secondary Series; the limits of each will be seen by reference to the chart.

LIAS.—The term Lias is supposed to be a corruption of *layers*, "and to allude to the riband-like appearance of the rock when seen in section." The Lias consists of strata in which an argillaceous character prevails throughout, but which are also remarkable for a quantity of calcareous matter mingled with the clay, and forming occasional bands of argillaceous limestone. The fossils of the Lias group are the ammonites,

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belemnites, and "those singular suarians whose skeletons remind us of lizards, crocodiles, and fishes." Ink-bags of considerable size, analogous to those of cuttlefish, are also found.

SANDY MARL STONE.—This rock, which forms the lowest member of the Lias group, consists of an argillaceous carbonate of lime, mixed with sand. It is usually of a white or greenish color.

LIMESTONE.—The Limestone of the Lias formation is characterized by numerous marine exuviæ, for during the Lias period the seas appear to have swarmed with living beings. It is the secondary Limestone only which abounds in shells, and in some localities there are considerable beds of this rock almost entirely composed of the remains of marine animals. It is a well established fact that no inconsiderable portion of the Earth's surface has been formed by organic secretion, and the process is still going on extensively in the Pacific and Indian seas, where multitudes of coral islands emerge above the waters, and coral shoals and reefs occur at small depths beneath the surface of the water in which the animals may be seen. As one generation dies and leaves its calcareous remains, another succeeds, until the coral mass is raised to the surface, when the formation ceases.

SHALE.—Shale is an indurated, slaty clay, or clay slate, having a variety of shades, from a light drab to green or blue, and sometimes red color; the drab and green are, however, the most predominant. It is usually a dark co-

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lored, shelly formation, extremely fragile, disintegrating by exposure to air and moisture. It is an abundant product of nature, both in this country and in Europe.

THE JURA OR OOLITIC SYSTEM.

This system is divided into groups, which are distinguished from each other by their relative position in the scale of elevation, but more particularly by the fossils found in them; the remains which are characteristic of the preceding groups are not met with in this.

The ocean, during the Jurassic epoch, had its peculiar characters. It was inhabited by saurians eminently swimmers, the ichthyosaurus and pleisiosaurus, whose paws, in form of paddles, remind us of those of the chelonians of the present day. These voracious animals, all aquatic, took the place of the sauroid fishes of the carboniferous group, which had now disappeared. At the same period lived those flying saurians called pterodactyls, which peopled the air and completed the series of singular creatures of an ancient creation, but now entirely extinct. The Jurassic or Oolitic System is peculiar to the continent of Europe, but is not found in North America, where the transition is so abrupt from the new red sandstone to the green sand and other rocks of the cretaceous period.

Inferior Oolite.—Oolite, or Roestone, receives its name from the small globules, like the roe of fish, which are imbedded in it. In some

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instances the globules attain the size of a pea, and this variety has obtained the name pisiform oolite. The peculiar rounded grains which constitute the oolitic texture, consists entirely of lime, or an external coating of lime collected round minute particles of sand, coral, shell, etc. This is the first series of oolite deposites, consisting at first of layers of marl, intermixed with sand, then layers of ferruginous oolites and strata of compact limestone and clays.

Fuller's Earth.—The layers of *Inferior Oolite* are succeeded by clays more or less pure, and fitted for the purposes of the fuller; hence the name of Fuller's Earth. It is a variety of clay, compact but friable, unctuous to the touch, and of various colors, with a shade of green. It is useful in scouring and cleaning cloth, as it imbibes the grease and oil used in preparing wool.

Stonesfield Slate.—The strata consist of rubbly stone, with sand, imbedding large concretional masses of fine sandy grit, which, by exposure to the frost, admits of separation into thin slates. Skeletons of marsupial mammals, analogous to opossums, have been found in the beds of Stonesfield, and the fossil productions of its slaty limestone have long been celebrated. In these strata have been found the teeth and bones of a monstrous reptile called the megalosaurus, of fishes, and other remains. The vegetable remains consist of several species of *fucus*, palms, and tree-ferns.

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Cornbrash.—This is an Oolite bed, consisting of coarse, shelly limestone, clays, and sandstones. It is very probable that the name was derived from the excellence of the corn land, which results from the decomposition of the limestones, and their mixture with the sandstones and clay.

Oxford Clay.—This group at the lowest part consists of clay, with layers of calcareous grit and stratoid masses of limestone. Above these are found sands and limestones, which are more or less oolitic, and often ferruginous. Amidst the Oxford deposites are found flattened balls of stone, which have been more or less cracked in different directions, and cemented together by the mineral matter which fills the fissures. These balls are called Septaria.

Coral Rag.—The lowest layers of this group are ordinarily compact, greyish or yellowish, filled with polyparia or corals of a saccharoid structure, or those which have passed to the siliceous state. Some of the succeeding layers are oolitic, composed frequently of large, irregular grains, mingled with fragments of rolled shells. This group abounds in coral, and contains beds that are decidedly coral reefs that have undergone no change but that of elevation from the bottom of the deep and the consolidation of their materials. The Coral Rag presents all the characters of modern reefs, literally petrified; "it is a coarse limestone, almost entirely formed of madrepores and other stony corals, the whole

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being consolidated by calcareous and siliceous infiltrations."

KIMMERIDGE CLAY is of a blue, slaty, or greyish-yellow color. It is so named because it is well developed at Kimmeridge bay, in the isle of Purbeck. The organic remains which characterize this group are of the genera ostrea and exogyra of particular species, and sometimes in great abundance.

PORTLAND STONE.—Next above the Kimmeridge clay, and the last member of oolitc division, is the Portland Stone, which alternates with marly, sandy, or oolitic limestone. The same fossils characterize this and preceding group.

WEALDEN DEPOSITES.—These deposites are composed of alternate layers of limestone, sand, more or less ferruginous, and clay, the deposites of which are sometimes extremely thick. The series of deposites to which the term *Wealden* is applied presents the most striking example of an ancient fluviatile formation hitherto discovered.

PURBECK.—In this group there are entire beds of limestone composed of paludinæ, constituting what is called Purbeck. Limestone, clays, sandstone, and shelly limestone called also Purbeck marble. The limestone is frequently interstratified with layers of vegetable mould, trunks of trees, and buried beneath the whole is a petrified forest, in which the trees are still standing in a vertical position.

HASTINGS SAND.—These beds consist of sand, sandstone with calciferous grit, alternating with

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clay and limestone. At Hastings, (England,) sand and clay, with interspersions of lignite, with laminated shale, grit, and sandstone, constitute a long line of high cliffs. The general resemblance of these strata to fluviatile accumulations is most striking; the laminated structure of the clay and shales, the constant intermixture of minute portions of lignite, the absence of pebbles, the alternations of mud and sand, are lithological characters constantly observable in river deposites.

WEALDEN CLAY.—This group consists of a stiff blue clay, with septaria, argillaceous ironstone, and beds of shelly limestone, which compose the uppermost series of the assemblage of Wealden deposites.

CRETACEOUS SYSTEM.

The characters of the chalk formation appear to be those of vast oceanic basins, filled with the debris thrown down by its waters, and which enveloped the remains of its inhabitants; arenaceous beds prevailing in the lowermost, argillaceous in the middle, and cretaceous in the upper division of the series. Intrusions of thermal streams appear to have been abundant at certain periods, and the proofs are incontrovertible that throughout the entire epoch of its formation, its waters swarmed with living beings of the various orders of marine existence, all, or almost all the species being now extinct. The fuci show that it possessed a marine vegetation, and the drifted

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wood, fir-cones, stems and leaves, that it shows were bounded by dry land, clothed with forests; the fossil reptiles also afford additional confirmation of this inference.

Lower Green Sand.—The lower green sand below the gault, is formed partly of green and partly of ferruginous sand and sandstone with some limestone. The fossils of the green sand are marine, and some of them range through all the members of the series. The green grains of these deposites, have been found by analysis to consist of silicate of iron, and they agree in composition with chlorite.

Upper Green Sand and Gault.—The gault which separates the two arenaceous beds, is a stiff blue or black clay, abounding in iron pyrites, and shells which frequently possess a pearly lustre, while the upper part contains green particles of silicate of iron, then succeeds the upper green sand. The green sand formation receives its name from the prevalence of small green particles of silicate of iron distributed through the sand. It is also found in New Jersey.

Chalk and Chalk Marl.—The white chalk used in writing, consists almost purely of carbonate of lime. Although usually soft, this substance passes in some districts by a gradual change into a solid stone, used for building. The stratification is often obscure, except when rendered distinct by alternating layers of flint. These layers are from ten to four feet distant from each other, and from three to six inches in

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thickness; occasionally in continuous beds, but more frequently in nodules. These nodules and veins of flint which occur in the chalk show that water holding silex in solution must have been very abundant during the cretaceous period. Although often white, we find it in some places colored gray, yellow, red, &c. Sometimes it is oolitic in character, and becomes almost crystaline, even magnesian and in localities remote from crystaline materials which might affect it. The inferior part of the Chalk formation is frequently intermixed and soiled with clays, in this state it has been denominated *Chalk Marl.* Above it is more pure and at the upper part it frequently becomes sandy as in the vicinity of the Maestricht beds.

Maestricht Beds.—These beds consist of a calcareous free stone of a yellow fawn color, so extremely soft in the quarry that it may easily be cut with a knife, but it becomes harder and of a lighter color by exposure to the air. Then succeed beds of limestone of great thickness, shell corals, crustacea teeth of fishes and other marine remains occur in profusion, and the bones of a large and very remarkable reptile, called the Mosæsaurus.

The Cretaceous group prevails extensively in England and on the continent of Europe; and beds of the cretaceous period are found in New Jersey and other parts of United States upon the older rocks without the intervention of the oolite.

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TERTIARY.—During the Tertiary period the seas appear to have been much less extensive than they were in the more remote geological ages, and consequently the sedimentary deposites formed in those waters are of less extent and more isolated. Moreover, their formation was affected at different points of the globe and at different periods, and to follow their history in chronological order it is necessary to sub-divide them into four groups. The fauna of all the divisions of this period possess certain common characters, and one of the most remarkable of these is the existence of a great number of *mammals.*

EOCENE DEPOSITES.—The beds thus designated are a very variable series, consisting in England and Belgium of stiff clays alternating with sand; in Paris of a number of limestones and marls alternating with gypsum and siliceous strata, which are found deposited in basins or depressions of the chalk where that formation constitutes the fundamental rock of the country.

LONDON CLAY.—In the vicinity of London a stiff clay of a bluish-black color, abounding in marine remains, constitutes the great mass of the materials which fill up this ancient gulf of the ocean. Immediately upon the chalk there occur thick beds of sand and clay, and, in some instances, layers of green sand, which should not be considered a distinct formation, but only the inferior portion of the London Clay. This Clay is found immediately beneath the gravel, which

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so generally forms the sub-soil of the metropolis; it is of great extent and varies from three to six hundred feet in thickness.

Fresh Water Beds.—In Hampshire and the Isle of Wight there are tertiary strata composed of clays, sand and limestone, containing fresh water shells and remains of the same kind of animals as those which occur in the vicinity of Paris. This group extends over a considerable district.

Bagshot Sand.—Composed of siliceous sand and sandstone, and some beds of marl: fossils are very rare; but the teeth of pristis or saw fish, sharks, rays and other species brought to light in a railway cutting made in 1838, near Guilford, prove this sand to agree closely in age with the London Clay in which the same species are found.

The miocene formations corresponding for the most part with those named Middle Tertiary, will next claim our attention. Among the strata referred to in this division are those of Touraine in France, and Suffolk in England; for although there is a considerable difference in the fossils of these two groups, there is strong ground for suspecting that they were nearly contemporaneous.

Bordeaux Beds.—They consist principally of sand and marl in which are shell and corals, some entire, some rolled, and other in minute fragments. A great extent of country between the Pyrenees and the Gironde is overspread by tertiary deposits which have been more parti-

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cularly studied in the environs of Bordeaux and Dax, from whence 700 species of shell have been obtained. A large proportion of these shells belong to the same zoological type as those of Touraine; but many are peculiar and the whole may probably constitute an older division of miocene period than the fauns of the Loire.

Coraline Crag.—This deposite is generally calcareous and marly—a mass of shells and corals, passing occasionally into soft building stone. At Sudbourn, near Oxford, where it assumes this character, are large quarries, in which the bottom has not been reached at the depth of fifty feet. In some places the softer mass is divided by thin flags of hard limestone and corals placed in the upright position in which they grew.

Red Crag.—The Red Crag is distinguished by the deep ferruginous or ochreous color of its sands and fossils—the coraline crag by its white color. They are rarely distinguished for their extent or thickness, and their importance is not to be estimated by the diversity of the mass of strata or its geographical extent, but by the extraordinary richness of its organic remains, belonging to a very peculiar type, which seems to characterize the state of living creation in the north of Europe during the last part of the miocene era. Extensive series of miocene beds occupy the whole surface of both shores of the Chesapeake, and a similar series occur in

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Virginia. The lowest beds of the Chesapeake series are argillaceous, and the uppermost are sandy. Both series abound in fossils, and they are sometimes found to consist of little else than shell and remains of zoophites, often in a high state of preservation.

Pliocene or Newer Tertiary.—In Europe the Pliocene is chiefly represented in south Italy, in the Morea, and in the islands of the eastern archipelago, and important cotemporaneous beds exist in the valley of the lower Rhine, near Bonn, and a portion of central France, as well as in southern Russia. The Pliocene beds of the United States seem to belong chiefly to a very modern period; they exist to a very great extent in several localities. At the mouth of the Potomac, in Maryland, is a series of clay beds alternating occasionally with sand. The fossils are identical with those of the neighboring sea-coast—a positive indication of the nearness of these beds. Similar beds exist at Niagara, Kentucky, and in other parts of North America. In all cases the recent deposites are very striking.

Subappenine Beds.—The Appenines, that chain of hills which extends through the Italian peninsula, are flanked both on the side of the Adriatic and Mediterranean by the Subappenines, a low range composed of tertiary, marl, sand, and conglomerates, abounding in marine shells of those species and genera which prove that some of the strata were contemporaneous with the crag, and that others are referable to a more ancient

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epoch. These beds have resulted from the waste of secondary rocks which form the Appenines, and were dry land before these strata were deposited.

The greyish, brown, or blue marl of the Subappenine formations is very aluminous, and usually contains much calcareous matter and scales of mica. It sometimes attains a thickness of two thousand feet, and is charged throughout with marine shells, some of which lived in deep, others in shallow water, while a few belong to fresh water genera, and must have been washed in by rivers. The wood and leaves which occasionally form beds of lignite in some deposites, may have been carried into the sea by similar causes.

Norwich Crag.—Recent investigations have shown that the deposites provincially termed crag in Norfolk and Suffolk, England, all of which were formerly confounded together and referred to one period, may be subdivided into two very distinct groups; the newest is that developed in the vicinity of Norwich, and also at Southwold. The shelly beds of sand and loam were evidently accumulated where one or more rivers entered the sea.

Pliocene or Newest Tertiary.—This division corresponds generally with the post pliocene of Mr. Lyell, for the strata which are sometimes called modern are characterized by having all the fossil shells identical with species now living.

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The Tertiary deposites contain some small proportion of shells of extinct animals.

MARL.—Of the various substances composing lake deposites, Marl is apparently the most important. It occurs in various states of purity, from a marly clay which will scarcely effervesce with acids to a shell marl containing from seventy to eighty per cent. of lime.

Marl clay is a whitish, friable clay, with an admixture of lime. In these deposites are found bones of various mammals and other animals belonging to genera still in existence, but the species of which are now lost.

GRAVEL BEDS AND BOULDERS.—Erratic blocks and gravel cover the plains of Central Europe and the steppes of Russia. Almost the whole surface of North America, as far as it has been examined, has been found covered with gravel, pebbles, and boulders, varying greatly in thickness, and obviously of the same origin as similar deposites in Europe; and a region which has been called the great Atlantic plains, extending between the Alleghany mountains and the Atlantic ocean, together with the lower part of the great valley of the Mississippi, appear to be the districts where it conceals the underlying deposites to the greatest depth. On the borders of lakes Erie and Ontario there are very decided marks of the great drift which has elsewhere overspread North America, and the boulder formation containing marine shells extends into the valley of the St. Lawrence, as far down as

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Quebec, and at a height of at least three hundred feet above the level of the sea.

In many parts of North America the valleys are filled up, to the depth of twenty or thirty feet, with unconsolidated beds of earth of various kinds, and the heterogeneous mass contains in it abundant remains of large animals not now living in the country.

PEAT.

Peat, or turf, as it is often called, is a natural accumulation of vegetable matter, varying in age from last year's growth to that which was formed several thousand years ago, and in appearance from a loose fibrous mass of a brown color, to a dark and compact substance, resembling lignite or brown coal. It is forming in all marshes by the annual decay of aquatic vegetation, and is encroaching upon shallow lakes by a similar process. The plants which enter most abundantly into its composition are sphagnum palustre, or peat plant, a number of mosses, rushes, reeds, and other marsh loving tribes, crowned in some situations by heather, to whose antiseptic properties is ascribed the conservation and accumulation of the other vegetable substances. Formations of peat have been variously classified: thus;—common peat, composed of the stem, leaves and roots of marsh plants; woody peat derived from the branches, leaves, trunks, and roots of trees; peat-turf, the healthy turf which covers moorland districts; hill peat, when

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formed on the sides of declivities; and peat-bog, when it accumulates in hollow places or on flat marshy surfaces. Whatever distinctions may be made, the main facts connected with their formation are the same; they are individually the result of decomposed vegetation, accumulated under certain conditions and in particular localities. They are to be met with in almost all temperature and cold moist countries, whether in the northern or southern hemisphere.

The formation of peat, as has been stated, is confined to moist situations where the temperature is low, and where vegetables may decompose without putrefying. It is thus found in swamps and on declivities, where springs abound almost entirely composed of marsh plants; in the sites of ancient lakes covering layers of gravel, marl and silt, whose drainage has been choked, burying, and in part formed of, the trunks and branches of trees, which flourished upon those spots previous to their inundation. It increases with astonishing rapidity, instances having been known where fifteen inches in thickness have been formed in twenty years. Being light and spongy, full half its bulk is composed of water, and this retentive quality enables new races of plants to flourish long after the surface of the moss has been raised above the drainage level of the flat in which it occurs. When the moss has sufficiently accumulated to change its character from that of a shaking morass to a firm peat bed, the marsh plants die out, and are

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succeeded by heath and other vegetation, which carry on the process of accumulation at a less rapid, but still perceptible rate. Such is the ordinary mode of peat growth, concerning which there can be no difference of opinion, for many of the accumulations are still in progress; but respecting those collections of trees which are often found buried in the moss, geologists are far from being agreed.

SOIL.

Soils are formed by the dissolution of rocks and by the decomposition of vegetable matter. Rocks, whose elements contain an alkali, or alkaline earth undergo changes by which they are directly converted into soils. Some granites and greenstones are of this description. Aluminous rocks, soft slates and shales are eminently disposed to disintegration, they break down by moisture without freezing. The soils formed by the decomposition of rocks do not remain in the position where the operation took place, but are transported by the agency of water to different places, and often quite remote from it.

VOLCANIC ROCKS.

Porphyry.—In the modern acceptation of the term any rock which is compact or finely granular, and contains distinct imbedded crystals, is called porphyry whatever be its color. The base or paste of most porphyritic rocks is felspar, and the imbedded crystals are also felspar though

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there may be also small grains or crystals of quartz or other minerals. It has been stated that granite, by becoming finer grained, frequently passes to a state of porphyry.

A large class of trap rocks vary very little, except in the increase of felspar and state of induration. It passes from granular basalt to clinkstone, from clinkstone to trap porphyry, from trap porphyry to trachyte and felspar porphyry, and from felspar porphyry, with further admixture of mica and quartz, to granitic porphyry and granite. On the other hand, from greenstone there is a transition to syenite, and from syenite to true granite. In other situations, currents of lava form obsidian or volcanic glass, and between basalt, phonolite and pitchstone there is an almost imperceptible gradation.

Serpentine derives its name from its variegated colors and spots supposed to resemble the serpent's skin. The colors are most generally various shades of light and dark green, which are intermixed with spots and clouds; some varieties are red. When first broken it has some degree of lustre, and is slightly unctuous to the feel; when pounded the powder feels soapy. It is harder than limestone but yields to the point of a knife, and will receive a very high polish. It differs in composition from hornblende by having a larger portion of magnesia and less iron. It is an intimate combination of hornblende and talc. Its component parts are silex, alumine, magnesia, iron, lime and water. Dif-

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ferent speimens vary in their composition; hence the modifying terms magnesian and calcareous serpentine.

Volcanic Breccia.—Stones of enormous size are frequently projected from the craters of volcanoes, but the quantity of matter which they throw out in the state of scoria sand, and powder often exceeds that erupted in the state of lava, and is spread over distant countries. By the percolation of water the loose materials become agglutinated and form beds of volcanic breccia and tufa.

Sometimes the tufa is sufficiently solid for building stone. "Some volcanic rocks decompose rapidly and form productive soils; others resist the process of decomposition so effectually that, after the lapse of centuries, they present all the freshness of the most recent lavas."

Pumice seems to have been formed from trachyte exposed to an intense heat, which has reduced it to a fibrous mass. In some of the islands there are mountains of white pumice, or those which appear to be so; the mountain is not one compact mass but is composed of balls or globes of pumice aggregated together, but without adhesion. It is the opinion of some that the pumice was thrown out of a volcano in a state of fusion, and took a globose form in the air. Some of these balls of pumice do not exceed the size of a nut, while others are a foot or more in diameter. Many of them are so compact that no pores are visible to the naked eye; others con-

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tain pores and cavities, and are composed of white shining filaments. By a long-continued heat pumice melts into a vitreous semi-transparent mass, in which crystals of felspar are seen.

Alum Stone.—The saline products of volcanoes are not numerous. The sulphureous vapor and sulphuric acid formed by the combustion of sulphur during eruptions act upon volcanic and other rocks, and produce different combinations of which the most important are Alum, sulphate of magnesia, sulphate of iron, or green copperas and gypsum, muriate of soda, or common salt, and muriate of copper and of iron, are found in the craters of volcanoes.

Trachyte has generally a whitish or grayish color, a dull earthy fracture, and is more or less fine grained; sometimes the grains are very minute, and it has then a compact surface and sometimes a glistening lustre, in which state it becomes Pearl Stone. Its hardness is variable; some of the Trachytes are spongy and almost friable. Tracyhte melts into a grayish glass; it generally contains imbedded crystals of vitreous spar. It often contains crystals of mica and grains of iron sand, and lamina of specular iron ore. Augite is seldom found in the Trachyte of Europe, though it is common in the Trachytes of the Andes.

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TRAP ROCKS.

They are principally composed of felspar and hornblende, with admixtures of clay, augite, and occasionally hypersthene. Hypersthene, it will be remembered, contains iron, silica, and magnesia. It differs from common hornblende only in its foliated crystallization, and its pearly or metallic lustre. The greenstones occur in large indeterminate or tabular masses, and are often hypersthenic; the clinkstones differ little from the greenstones in mineral composition, but are more compact, split up into thin schistose-like fragments, and yield a metallic sound when struck with a hammer; the basalts are easily known by their columnar structure, their dark and compact aspect, and from their containing little spherical crystals of a greenish mineral called olivine; and the trap-tuffs are of all varieties, from a soft scoriaceous looking mass to a confused conglomerate of fragments of basalt, greenstone, sedimentary rocks, etc. Some of the most interesting scenery in this country is formed by greenstone columns standing upright, or leaning only a few degrees. The Palisadoes, on the Hudson, a few miles above New York, are an example of this kind. In Oregon, where the Columbia river passes through mountains of trap, and probably basalt, from four hundred to a thousand feet in height, a vastly more extensive formation of this kind exists. The trap

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rocks of the carboniferous era are easily distinguished from those of any other, partly by their darker color, and from the fact of their yielding bitumen by distillation, and partly from the presence of basalts and of trap-tuffs, containing fragments of limestone and shale. Basalt or greenstone sometimes overlies, as if poured in a state of liquid lava over the subjacent strata; and trap-tuffs also overlie, from their evidently having been strewn abroad in the form of volcanic dust and ashes. The structure of the tuffs and porphyries is massive and indeterminate; of the greenstone sometimes massive, but generally cuboidal, and of the basalts always columnar. This difference in the structure and texture of these rocks seems to have arisen not so much from any difference in their mineral composition as from the circumstances attending their cooling. The same substance which when suddenly cooled forms a black glass or obsidian, will by a slower process of refrigeration form basalt, or by a still slower pass into earthy tufa.

METALLIC VEINS.

Metallic veins are of most frequent occurrence in rocks of the primary and transition series, particularly in those lower portions of stratified rocks which are nearest unstratified crystaline rocks; they are of rare occurrence in secondary formations, and still more so in tertiary strata. Dr. Buckland, in remarking upon this subject, says the advantageous effects of the disturbance of the

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surface of the earth has been to produce rents and fissures in the rocks which have been subjected to these violent movements, and to convert them into receptacles of metallic ores accessible by the labors of man. The greater part of metalliferous veins originated in enormous cracks and crevices penetrating irregularly and oliquely downwards to an unknown depth, and resembling the rents and chasms which are produced by modern earthquakes. The general disposition of mineral veins within these narrow fissures will be best understood by reference to the chart. The narrow lines, which pass obliquely over the lower portion of the chart, represent the manner in which rocks of various ages are intersected by fissures which have become receptacles of rich treasures of metallic ore.

Several opinions have been entertained in regard to the manner in which these veins and chasms have been filled with metallic ores and earthy minerals of a different nature from the rocks containing them. Werner believed that veins were supplied by matter descending into them from above in a state of aqueous solution, while Hutton imagined that their contents were injected from below in a state of igneous fusion. Another refers the filling of veins to a process of sublimation from subjacent masses of intensely heated matter into apertures and fissures of the superincumbent rocks. While a fourth considers veins to have been slowly filled by segregation, or infiltration; sometimes into contemporaneous

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cracks and cavities formed during the contraction and consolidation of the originally soft substances of the rocks themselves; and more frequently into fissures produced by the fractures and dislocation of the solid strata. Segregation may have taken place in consequence of some electro-chemical agency *continued for long periods of time.*

DESCRIPTION OF METALS AND MINERALS.

AGATE commonly consists of chalcedony, quartz, and jasper, in angular and concentric lines; the crystals of quartz which frequently exist in the interior, tend to show that it has been formed by infiltration of siliceous particles into preexisting cavities; it owes its color to iron and manganese. The exterior of Agate, is rough and spheroidal, and generally of a dirty green color.

BISMUTH has a metallic appearance of various colors generally resembling the hue of a pigeon's neck, changeable as the light strikes it, which peculiarity distinguishes it from granular lead ore. It is soft, and melts the moment it receives the flame into white globules. It is not malleable. It is found in a native state and combined with sulphur, it sometimes accompanies the ores of silver, lead, cobalt and nickel. It is used with tin, to form a soft solder, by glaziers, and is also a constituent of pewter.

CHALCEDONY often occurs amongst the pebbles

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of the sea shore; it is of a very close texture, fractures not shining; color generally pale milk blue, translucent; it is often marked by straight opaque white lines parallel to each other, and frequently resembles white cornelian.

Molybdena is not abundant, though it occurs in many situations; it is commonly in small foliated patches of a lead color. It crystalizes in six-sided tabular plates. It does not melt under the flame of the blow-pipe. It resembles black lead (plumbago) and may be distinguished from it by its marking porcelains or earthern ware with a greenish streak. It is usually disseminated in quartz, and being considered ore of the oldest minerals, it always occurs in primitive rocks. When it is distilled with nitric acid it forms a substance called molybdic acid.

Platina is found in grains accompanying gold. It is heavier than granular gold, and is of a white color resembling silver, hence it is called platina, the diminutive of plata, meaning silver in the Spanish language. It is only met with in some peculiar gold washings in Mexico, and in one or two in Brazil. It is reported to have been found along the banks of the Red river in the United States, but some further demonstration is necessary to authenticate the statement. It is distinguished from all other metals by its great weight.

Copper Ores are found in abundance and in great variety. Copper is not uncommon in its native state, in which form it is found massive,

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compressed in leaves, foliated, and branch like. The ores of this metal are more or less hard as they are rich or poor, the best being the softest. The purity of the ores may be tested by placing a small particle of it on a piece of charcoal with a little borax, and on applying the flame of the blow-pipe, and if the metal be rich, it will be reduced to a bead of pure copper. The ores of copper have commonly a yellow appearance, the poorer ores resembling iron pyrites; the richer ores are of a gold yellow color; some are beautifully iridescent, and are therefore called Peacock Copper. Some ores of this metal have a shining metallic-gray lustre, not unlike iron; others are black, ruby-colored, and brick-red. Carbonates of copper are perhaps the most beautiful in this class of metals; their colors are green or azure blue, of various shades. Phosphates of copper are of a dark green color, with black spots; they may be known by their easy fusion before the blow-pipe. Muriate of copper communicates a beautiful emerald-green color to flame. Copper is commonly found in the veins which traverse clay and graywacke slate.

Copper mines have been found in various parts of the United States and territories. A copper mine has recently been opened at New Brunswick, N. J., by Mr. Albert Cammann, of Somerville. The ores are the green and blue carbonates of copper, containing probably about sixty per cent. of the metal, and also the grey sulphuret of extraordinary richness, exceeding

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seventy per cent. of the metal. A mine of copper, also, has recently been opened in Hunterdon county, N. J., which is believed to be extensive and valuable.* But it is to the Lake Superior mines that we are to look for large supplies of this metal. A gentleman, writing from that country, says: "It is, however, the hidden treasures, the mineral wealth of the copper region, which gives importance to this otherwise sterile soil. A large tract of country, embracing the mineral district, was purchased from the Indians in 1842, and the government granted leases, to practical miners, of locations of nine square miles each, for a term of nine years, on their paying to the government six per cent. of the mineral, by way of rent. Several companies have been carrying on mining operations successfully in different portions of the district. The Eagle river locations are known to be rich in mineral wealth, both silver and copper; and ores are now being taken from the earth of a quality much richer than any found heretofore in any part of this richly productive country." A letter from the cliff mines states that "appearances are so favorable as scarcely to be believed. Masses of native copper, so far uncovered as to show from ten to twenty tons, have been showing themselves in several mines. Native silver is found in some veins in masses weighing from one ounce to five pounds. You will have heard ere this of the

* The accounts in regard to the New Jersey mines have since proved incorrect.

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arrival of sixty tons of silver ore from the Pittsburgh company, and three hundred and eight tons more selected, ready to forward."

Black Lead.—A mineral composed of carbon and iron, constituting carburet of iron. It is known as plumbago, and graphite, and is used in the manufacture of lead pencils. It is found in primitive rocks.

Bitumen is composed of carbon and hydrogen, and is known to exude from the lava of recent volcanoes. It is highly inflammable, and greatly resembles pitch.

Diamonds may be easily known from stones which are cut to resemble them. Light will pass through crystal, paste, etc., whereas in the diamond the rays are refracted to the surface, which gives it the preëminent rank it holds in society, and is the cause of its transcendant brilliancy, which fascinates the eye of the most distant beholder. The diamond is exceeding hard, cutting other hard substances with ease; it receives little or no impression from the file, having a sort of shining lustre, a crystaline form, and is a regular octahedron. Those brought from Brazil or India in a rough state are not as large as a small hazel nut. They are commonly found in alluvial soils, yet, according to Dr. Emmons, "the diamond has been found in secondary deposites, and in a district which abounds with debris of sandstone rock, which are often aggregated or cemented together into a sort of coarse breccia. It occurs likewise in the loose sand of plains and rivers."

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The diamond is the purest form of carbon. It is used as an ornament, for cutting glass, for engraving, and for cutting and polishing other hard stones. Says the Georgia Times: "We were shown a diamond of the first water, about the size of a pea, belonging to the Rev. Pendleton Cheek, of Henry county. It was found in the Union gold mines. Mr. Pendleton informed us that several others had been found in the same place, though not so large as the one shown us."

JASPER.—This does not occur as a constituent part of beds or mountain masses. It is a kind of siliceous flinty slate, colored red, brown, green, and vellow, and contains a large portion of the oxvd of iron in its composition. There are beds of jasper of considerable magnitude in some parts of the Appenines, covered by rocks of serpentine. Lydian stone, which is a black siliceous flint slate, is by some geologists called black jasper.

GARNET is a well known precious stone, of a reddish or wine color, composed of silicates of alumina, lime, iron, and manganese. It occurs imbedded in mica slate, granite and gneiss, and occasionally in limestone, serpentine, and lava.

ZEOLITE is a mineral, composed principally of silex, lime, and alumina. Its color is white, passing into reddish, with yellowish or greyesh tints. It is commonly found in trap or basaltic rocks.

PYROXENE, or AUGITE, is a greenish mineral found in many igneous rocks. It occurs foliated and in grains. It is sometimes of a greyish white

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color, and is the type of a class to which hornblende and actinolite belong. It is derived from two Greek words, which signify, "stranger to fire," and is supposed to have preëxisted in the volcanic minerals containing it, and not to have been formed by fire.

CHRYSOLITE, or PERIDOTE, from the Greek, chrusos, gold, and lithos, a stone, a golden stone from its color. It is the topaz of the ancients. Topaz has various shades of yellow, green, and blue color. Some specimens from Brazil are of a yellow color, resembling gold, consequently they are called crysolites.

CALCAREOUS SPAR has a smooth, glasslike, shining surface; when broken the fragments are of a rhomboidal form. It effervesces with acids, even with strong vinegar, if dropped upon it when reduced to powder. If transparent, it has the property in a high degree of presenting two images of an object seen through it, whence it has been called *Double Refracting Spar*. To know if a substance is calcareous spar, apply the point of a knife, and if the body is brittle and easily acted upon and a white powder is produced, it may be presumed to be calcareous spar. It may be discovered by placing a few fragments on a hot fire shovel, when they will become opaque and burn to lime, which may be known by its styptic taste, or by pouring water upon it, when it will fall to powder with a hissing noise.

CHLORITE, is so called from its greenish-black color. It is rarely crystalized in foliated struc-

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ture, and in the latter state it forms a greater portion of that slightly unctuous greenish slate called chlorite slate.

Fluorine is a union of hydrogen with fluoric acid. Fluor spar is composed of lime and fluoric acid. Its color is generally light blue or emerald-green, sometimes green, rose-colored, and red. It never forms a part of the rocky strata. It is usually associated with deposites of lead, zinc, and silver, both in beds or veins. It is found in all the rock formations, as primitive, transition, and secondary.—*Dr. Emmons.*

Barytic Minerals are commonly found in veins, and may be known by their great weight. They yield to the knife, are frequently massive, and of an earthy texture, resembling chalk, also crystalized and transparent. Barytes is an alkaline earth, becomes caustic on being exposed to strong heat, and ultimately melts. Carbonate of barytes is more rare than sulphate of barytes; like it, it is very compact, and may be known by its great weight; it effervesces in diluted acids. Sulphate of barytes is found in countries of limestone formation; it occurs also in sandstone and shale, where it is found earthy and crystalized, in great quantities, considering it is produced only in veins. Carbonate is less abundant.

Pyrites, the most abundant of all minerals, is of a yellow color, frequently beautifully crystalized in brilliant groups or detached cubes; it occurs, also, massive. It is composed of sulphur and iron, (sulphuret of iron.) Those little shining

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crystals, so abundant in some kinds of roofing-slate, are cubic pyrites. It is found also in sparry limestone. This mineral is said to produce spontaneous combustion.

Sapphire (Rombohedral Corundum), is found in crystals in the massive varieties. The most perfect of the species, as the sapphire and oriental ruby, are met with principally in secondary deposites, as the sand of rivers, etc. It has a variety of colors, as red, green, yellow, blue, grey, and white; it is both transparent and translucent, with a vitreous lustre. There are few localities of sapphire in the United States; one is at Newton, in the county of Sussex, N. J. It is there found imbedded along with a white felspar, in limestone, near the junction of the granitic, sienite, and white granular limestone.—*Dr. Emmons.*

Oxyd of Iron.—Rust is an oxyd of iron; the peroxyd of iron is the highest degree of oxydation.

Cobalt.—The ores of cobalt are generally accompanied by a large portion of arsenic. They have a whitish grey color, and metallic lustre, sometimes approaching to black; they are very heavy and much harder than lead ore, which they in some degree resemble. Under the flame of the blow-pipe it emits the fumes of arsenic. The blue varieties of this ore occur in sandstone, while the others are found in mica and clay slate, with lead, copper, and manganese, in detached splendid crystals of a white metallic lustre, gene-

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rally in cubes or octahedrons variously modified. It is used to give the beautiful blue color to China and earthenware, and also in enamel painting.

MANGANESE is a dark colored substance, frequently attendant on iron ores and ochreous substances. It generally is found near the surface, and is used in bleaching, in the manufacture of glass. Manganese is earthy, in its general appearance brown or black, soils the fingers, and frequently contains delicate fibres of a bright iron-like lustre. When heated with muriatic acid over a lamp, chlorine gas will be disengaged, which may be known by its suffocating odor, and from the fumes discharging the color from moistened printed linen.

LEAD.—The ores of this metal are both various and numerous; they are of white, green, yellow, and red color; they all easily yield to the blowpipe, and melt in small globules, and may be easily discovered by their weight. If a particle of the ore be reduced to powder, and put into a glass vessel, with a few drops of diluted nitric acid, it will be dissolved with a brisk effervescence. Lead has been found in various portions of the United States. Valuable mines of lead are found along the Ohio river, on the Illinois side, about thirty miles above the mouth of the Cumberland river, the ores are said to be equal at Galena. It is supposed that a silver mine exists near the falls of the Ohio. Says a miner, writing from Iowa: "It is impossible to conceive

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the value of the many lead mines recently discovered in Iowa and its neighborhood. A miner at Dubuque, while sinking a shaft, came upon a large cave containing the richest veins of lead ore that had yet been discovered in that country. The cave is one thousand feet in length, from fifteen to forty in breadth, and from twelve to thirty feet in height. But the peculiar charm of the cave is in the mineral it contains. Descending by a small shaft on the floor into a drift, the glittering ore reflected back the light in every direction. It lays in detached junks, some weighing a thousand pounds, embedded in the usual red silica, but by what wondrous chemistry, and when it was formed, or if it grew, where it gets its constituent parts, are among the mysteries." Lead occurs in large or small veins in almost every rock formation, but principally in limestone. It is sometimes found in connection with silver.

Tin.—The ores of Tin resemble those of iron in some instances. Tin is one of the heaviest ores, but the lightest of metals. It presents but few varieties. It *is* sometimes of a resinous color, but commonly approaching black. The crystals occur in groups, presenting planes often intersecting each other, which have a high lustre. It is found in very narrow delicate veins only in the primitive rocks, granite, and slate. It is met with, also, in alluvial soil in small hard nodular pieces called Stream Tin. Some have divergent, striæ and ligneous appearance, hence called

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Wood Tin. Sheet Tin, so much in use for various purposes, is generally rmed by immersing thin plates of iron in melted Tin.

Zinc.—The ores of Zinc form two distinct substances, blende or black jack, and calamine, both of which present several varieties, though they form the same metal. Blende is commonly black, brown or yellow, of different shades. It is massive, and often appears in clusters (confusedly crystalized) upon the surface of other minerals. It may be cut, and a light colored powder produced by scratching it; some of the yellow varieties when rubbed produce phosphorescence. These ores resemble tin, but they are neither so heavy nor so hard. Under a strong flame of the blow-pipe blende evaporates and goes off in white flakes.

Calamine occurs in masses, brown, yellow and green; also crystalized in divergent transparent crystals forming elegant groups. It is generally porous and cellular, not unlike bone, but sometimes compact; and this species when struck, yields a metalic sound. Some kinds become electric on being warmed, and are hard enough to give sparks with steel.

The presence of Zinc in any ore may also be known by mixing a small portion of it with a few grains of copper filings and a little charcoal; on cautiously applying the flame of the blow-pipe, so as not to volatilize the Zinc, the copper will be converted into brass. It is usually found in limestone countries.

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MERCURY, or Quicksilver, is the only metal which is found naturally in a fluid state. It occurs in this state in semi-indurated clay, in sandstone, and other earthy productions; it is also found in small or large globules commonly attended with a red substance. The ores from which the greatest quantity of Mercury is obtained are called cinnabar, which when rich are extremely heavy compared with iron. They are of a light or brown-red color. Some varieties are dull, others bright and shining. They may always be known if rich by their great weight. Quicksilver once seen can not be mistaken; it is always fluid in our temperature, but may be rendered solid by producing artificial cold. The ores of Mercury are not generally distributed, but where they are found they occur in considerable quantities; it has been recently discovered in large quantities in California and New Mexico; it commonly occurs in regions where silver and gold abound.

ARSENIC.—Native Arsenic has a whitish color like tin, approaching sometimes to lead-gray; it soon tarnishes, and becomes dark gray on exposure to the air. It has a metallic lustre, and a composition both granular and compact, though it sometimes occurs in reticulated and stalactite shapes. Before the blow-pipe it exhales the odor of garlic with copious white fumes. It is generally found in veins of slaty rock with other mineral products.

TITANIATE OF IRON consists of a union of an oxyd

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of Titanium and an oxyd of Iron. It is only found in one locality in France. Titanium is obtained from a mineral found in Hungary called red schorl, and in a substance from Cornwall, termed menachanite.

Silver.—Native Silver and other Silver ores occur with quartz, calcareous spar, etc., filling fissures and veins in the stratum, also accompanying other metals, and not unfrequently combined with them. It sometimes occurs in delicate curled fibres, of a silk-white color; these fibres are tough and flexible, often surrounded by a black, earthy soot-like substance. It also occurs massive and branched in strong ramifications, or leaf-like, and has often a fine rich metallic lustre resembling tin, but subject to become tarnished by exposure to the atmosphere. Silver in its native state can not be mistaken after having been once examined. It yields to the knife, being little harder than lead. It is malleable, and melts into a beautiful white globule. Ruby Silver, so called from its red color, is the most beautiful of the ores of this metal. It occurs sometimes in translucent six-sided crystals. Muriate of Silver resembles horn, and hence it is called Horn Silver. It is so soft that it may be indented by the nail. It is extremely easy of fusion, melting even in the flame of a candle. Although it is a very rich ore, yielding seventy per cent., still it has not the least appearance of a metallic substance.

The principal mines of Silver are in Mexico and Peru, which produce ten times as much as

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the whole world besides; it is reported that forty millions of dollars have been coined from these mines annually.

Gold is generally obtained from the alluvial soil in small lumps or particles, called grains, or gold dust, seldom so large as a pea. In Brazil, where Gold is found, the country does not contain one subterraneous excavation. What is termed a mine is nothing more than the bed of a river, or the bottom of a ravine, where the soil is composed of alluvial matter, consisting of rounded pebbles, gravel, etc., and sometimes containing precious stones besides Gold. This goes to prove that the particles of Gold have been disseminated in the mountains, and on the decomposition of the rocks have been washed down by heavy torrents of rain to their present situation. The Gold is found by submitting the alluvial soil to a process of washing, by which it is freed from the earthy matter and other substances. Particles of Gold are sometimes so extremely delicate that they can not be separated from the heavy ferruginous matter without mercury, which, on being strongly triturated, takes up the Gold and amalgamates with it. Gold dust is an article of commerce in Africa, and it is often adulterated with such pyrites as is nearest to it in color, and not unfrequently with brass filings, which the merchants know how to detect, and for the want of this sort of knowledge many have suffered great loss. Gold occurs in a foliated form, in Transylvania and Siberia, in veins filled with other sub-

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stances, also laminated, imbedded, crystalized, and disseminated. Rounded lumps of it as well as particles called Gold dust, have been found in the alluvial soil all over the world, but more particularly in Africa and South America. Native Gold varies greatly in its purity; sometimes it contains one-fourth part of silver or copper, but never quite pure. Gold has never been found in veins, although it appears in short ramifications in quartz, but nothing like a regular vein has been heard of in any of the Gold districts filled with Gold. The most productive mine of Brazil was in alluvial soil, under a bed of micaceous iron ore, where a thin stratum of Gold in delicate folds was intermixed with it. Gold has been discovered in this country in many of the Southern States, and recently in California, where it occurs in abundance in alluvial soil, dry ravines, beds of rivers, and in nests or pockets in talcose slate. As a particular description of the Gold regions of California will be given in another place, I shall in conclusion give one test of the purity of Gold. "Place a little Gold dust in a glass tube or earthen-ware saucer, and pour nitric acid upon it; then hold it over a flame, or upon a few embers, until the red fumes (nitric vapors) arise; if it be pure Gold, the liquid will not become discolored; but if pyrites, or brass filings, etc., which resemble Gold, should have been mixed with it, the acid will become turbed, green, and black, discharging bubbles of air. By repeating

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the process, the Gold may be freed from all impurities."

IRON.—Ores of Iron present themselves in great abundance, and exhibit a variety of appearances. The most common method of detecting them, however, is by their action on the magnet. If Iron occurs in the form of a sulphuret, it may be ascertained by heating it, when a sulphurous vapor will be exhaled. The most common ore in England from which Iron is made is clay iron stone, which may be considered a deposite, and is almost always found near coal, which is so necessary for melting it. In the United States Iron ore is found in great abundance, occurring in masses, veins, and deposites. My limits will only allow me to call your attention to some of the more valuable mines in the northern counties of New-York.

Says Professor Emmons:—"Magnetic oxyd is found in two geological forms; 1st. That of masses; 2d. That of veins In the northern counties we have numerous examples of both." He uses the term masses as applied to those portions of Iron ore which do not appear to have any well defined limits. Veins are limited by what may be termed walls. The veins do not consist entirely of the magnetic oxyd; other minerals sometimes fill a portion of them, such for instance as hornblende, felspar, and quartz. Veins are sometimes of considerable longitudinal extent and often coinciding in direction with the strata. It

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occurs in parallel belts, for rarely is found a single isolated vein or mass.

The Penfield ore bed, situated near Paradox lake, in Essex county, is both extensive and rich. The ore is black, and gives throughout the mass a black streak; the lustre is only where the fracture is recent. The width of the vein is about forty feet, running north-east and south-west. The vein yields fifty per cent, of the ore, although it contains quartz and other rocky matter.

McIntyre Iron Works.—The Iron ores of Adirondack all belong to the magnetic oxyds; all are black in the mass, and give the same black streak, and the same colored powder. The ores can not be arranged among the bright metalic ones, as their lustre is generally dull except in places where a granule is broken. The ores which have a brilliant lustre, and are not disposed to crumble, do not reduce so easily in a forge as many of the darker ones. The ore of these beds has a jointed structure and breaks into tabular masses. "These masses appear to be coeval with the rock which encloses them, or such a view comports best with many facts which are brought to view in mining. The rock which encloses the ore is unstratified, from which fact we infer the igneous origin of the enclosed mass of ore. The time will come when these mountains of ore will be laid open, and their structure perfectly understood; and the relation between the rock and ore disclosed to the light of day."

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The McIntyre ore bed is probably the richest and most valuable of any which has been discovered in this state. Says Professor Emmons, in regard to the richness of that wild region:—"For aught that appears to the contrary, the interior of the Earth along the valley of the Adirondack river, may as well be composed of ore as of rock or stony matter. In all the uncertainty which lies over the subject, I am disposed to believe that the whole valley of Adirondack is underlaid by the magnetic oxyd.

Crag Harbor Ore.—"Situated directly upon the shore of Lake Champlain, about half a mile below Fort Henry, in a cliff which almost overhangs it, and, about fifty feet above the water. The vein is about twelve feet wide dipping at an angle of about thirty-five degrees, and lies in hornblende rock, with which the ore is somewhat mixed. Black mica occurs in this vicinity. The range of gneiss and hornblende is important in consequence of furnishing so many veins of Iron ore, some of which afford Iron in great abundance and of the very best quality."

"Specular Iron Ore, as it occurs in the northern counties, is in two conditions, that of a powder or red mass, which strongly soils whatever comes in contact with it, and in brilliant, highly crystaline particles or crystals with the lustre of polished steel."

Bog Ore.—Deposites of this kind are found in different parts of the state of New-York. A deposite of this ore was found surrounded by a rock

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highly charged with sulphuret of Iron, which decomposing gradually by the action of the air and water furnished a large amount of ore. Bog ore accumulates around springs in low swampy places. Uusually this ore is a mixture of an oxyd and carbonate, and the water being charged with these substances deposites them in consequence of its solvent powers. In some instances beds of this ore have been completely exhausted and replenished again in fifteen years. In Albany and Saratoga counties localities of bog ore are numerous. They are formed by filtering rain water, which holds some carbonic acid in solution, and dissolves the oxyd of Iron in the sand through which it passes.

MINERAL WEALTH OF THE UNITED STATES.

The Potomac and Alleghany coal and iron basin lies between two ridges of the Alleghany mountains, in Maryland, at a distance of about two hundred miles from Washington. These mountains run nearly parallel, at a distance of five miles from each other, in the centre of which flows the Potomac and its tributaries, cutting the earth to the depth of twelve hundred feet, exhibiting to view more than twenty strata of coal and about the same of iron ore. This, it is believed, is unparalleled in the history of the world, that such a vast body of good ore should lie above water level, and be immediately associated with every material necessary for its reduction on the

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spot. The coal is of the finest quality and perfectly adapted to the purposes of making iron, and the ore consists of the brown hematite, which has been analyzed and found to yield from sixty to sixty-three per cent. of pure Iron.

VOLCANOES, EARTHQUAKES, ETC.

"*The cause of volcanoes, earthquakes, and other subterranean movements* has been the subject of several theories, but is yet by no means very satisfactorily determined. The most prevalent opinion is that which connects them with one great source of central heat—the residue of that incandescent state in which our globe originally appeared. By this hypothesis it is assumed that the crust of the Earth is of various thickness, that it contains vast caverns, and is extensively fissured—primarily by unequal contraction from cooling, and subsequently by subterranean agitations. Through these fissures water finds its way to the heated mass within; this generates steam and other gases, and these exploding, and struggling to expand, produce earthquakes and agitations, which are rendered more alarming by the cavernous and broken structure of the crust, and the yielding material upon which it rests. Occasionally, these vapors make their way through fissures and other apertures as gaseous exhalations, or as hot springs and jets of steam and water, like the geysers of Iceland. On the other hand, when the expansive forces within become so powerful as to break through the Earth's crust,

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discharges of lava, red hot stones, ashes, dust, steam, and other vapors follow; and repeated discharges of solid material gradually form volcanic cones and mountain ranges. It does not follow, however, that volcanic discharges must always take place at the point where the greatest internal pressure is exerted, for volumes of expansive vapor press equally upon the crust and upon the crust and upon the fluid mass within, so that the latter will be propelled towards whatever craters or fissures do already exist. This theory of central heat is further supported by the occurrence of igneous phenomena in all regions of the globe, and by the fact that most volcanic centres are in intimate connexion with each other—a commotion in one district being usually accompanied by similar disturbances in another. The only other hypothesis which has met with countenance from geologists, is that which supposes the internal heat to be the result of chemical action among the materials composing the Earth's crust. Some of the metallic bases of the alkalies and earths, as potassium, the moment they touch water, explode, burn, melt, and become converted into red-hot matter, not unlike certain lavas. This fact has given rise to the supposition that such bases may exist within the globe, where, water finding its way to them, they explode and burn, fusing the rocks among which they occur, creating various gases, and producing caverns, fissures, eruptions, and other phenomena attendant upon earthquakes and volcanoes. As yet,

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our knowledge of the Earth's crust at great depths is excessively limited; we know little of the chemical and magnetic operations which may be going forward among its strata, and we are equally ignorant of the transpositions which may take place among its metallic and earthy materials; but judging from what we do know, this theory, however ingenious, seems by no means adequate to the results produced. It is true that there occurs nothing among the products of volcanoes at variance with its assumptions; but the magnitude, the universality, and the perpetuity of volcanic action point to a more stable and uniform source—that source being the internal heat or residue of that igneous condition in which our planet originally appeared."

Eruptions of Etna.—Etna appears to have had eruptions from the earliest times of history, causing the desertion of extensive districts of country; before the Trojan war, and up to 431 years before Christ, there had occurred three eruptions of this mountain. The first eruption of which we have any particular description was the great one of 1663. "An earthquake, previous to this eruption, had levelled many of the villages and towns in the neighborhood, and at the commencement of which an extraordinary phenomenon happened in the plain of St. Lio. Here a fissure six feet wide, and of an unknown depth, opened in the ground, with a loud, terrific, crashing noise, and ran in a tortuous course nearly to the top of Etna. Its direction was from

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north to south, and its length twelve miles. This fissure as it opened emitted vivid flashes of light. Five other parallel fissures of considerable length afterwards opened one after the other, emitting smoke, and giving out the most horrid bellowings. which were heard to the distance of forty miles. The lava, during this eruption, having overwhelmed and destroyed fourteen towns, some of them containing three or four thousand inhabitants, at length arrived at the walls of Catania, a populous city, situated ten miles from the volcano. These walls had been raised sixty feet high towards the mountains, in order to protect the city in case of an eruption. But the burning flood accumulated against the wall so as to fill all the space around and below that part, and finally poured over it in a fiery cataract, destroying everything in that vicinity. From Catania, the lava continued its course until it reached the sea, the distance of fifteen miles from its *source*, in a current about 1,800 feet broad and forty feet deep. While moving on, its surface was, in general, a mass of solid rock or cooled lava, and it advanced by the protrusion of this melted matter through this hardened crust. As an illustration of the intense heat of volcanic matter, the Canon Recupero relates, that in 1766, he ascended a small hill, composed of ancient volcanic matter, in order to observe the slow and gradual manner in which a current of liquid fire advanced from Etna. This current was two and a half miles broad, and

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while he stood observing it, two small threads of lava, issuing from a crevice, detached themselves from the main stream, and approached rapidly towards the eminence where he and his guide were standing; they had only just time to escape, when they saw the hill on which they stood a few minutes before, and which was fifty feet high, entirely surrounded, and, in about fifteen minutes, entirely melted down into the burning mass, so as to be incorporated with and move on along with it."

Elevation of Land and Islands by Volcanic Power.—In November, 1822, there occurred a series of subterranean convulsions on the coast of Chili, South America, which continued three months, and shook that part of the country to the extent of 1,400 miles from north to south. After the first shock the whole line of coast along Valparaiso to a distance of 100 miles was found to have been raised above its former level. It was also found that the former bed of the sea along the shore was laid bare with muscles, oysters, and other shell-fish adhering to the rocks on which they grew, and an abundance of dead fish on dry land. At Valparaiso, the elevation of land was three feet; but at other places the rise was from four to five feet.

There arose from the sea a new island among the Aleutian group, in the year 1806. The island was about four miles in circumference; it does not consist of ejected volcanic matter, but of solid rock thrown up from the bottom of the sea.

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Eight years afterward another island was added to the Aleutian group from the bottom of the sea, much larger than the former, and its highest part was raised to the astonishing height of 3,000 feet above the level of the sea.

Eighteen small islands were elevated from the sea in the vicinity of the Azores in the year 1757.

Many other instances of the kind might be recorded to show that islands are elevated from the ocean by the force of volcanic action.

Monte Nuovo, near Naples, was thrown up by volcanic power on the night of the 29th of September, 1538. This mountain is nearly a mile and a half in circumference, and its elevation is about 440 feet above the level of the Bay of Naples.

SUBMARINE AND SUBTERRANEAN FORESTS.

Geologists have been at variance in regard to the origin of submarine forests; one class believe that they merely occupy low flat districts which have been successively lost and won by the sea. The sites of these so-called forests are generally flat districts, a few feet under the ordinary level of the sea, and when exposed after a storm or during ebb tides, present a series of half pulverized stumps with their roots imbedded in a stratum of clay, evidently the soil in which they grew. "The stumps have undergone different

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degrees of petrefaction, and many are encrusted with iron pyrites. Others suppose the trees to have grown in low alluval tracts, which were sheltered from inroads of the sea by sand hills and other barriers; that on these barriers being broken down, the forests were overthrown, and their trunks and roots covered by the inundating waters of the ocean. This latter opinion has few adherents, for the submergence of land is as common a phenomenon as its elevation."

"Subterranean forests are found in estuaries now silted up, in ancient lakes, and under ordinary peat bogs. When they occur in estuaries, or low alluvial lands adjoining the sea, they would seem to have been drifted from inland by river inundations, for most of the trunks and branches lie in such a position as to forbid the supposition that they grew in these situations. A very interesting case of this kind," says Professor Phillips, "was exhibited some years ago by the deep cutting of a canal connecting Aire and Calder navigation. At a depth of twelve feet from the surface of the fine alluvial sediment, here occupying the broad valley of the Aire, a quantity of hazel bushes, roots, and nuts, with some mosses, fresh water shells, and bones of the stag were met with. In some parts of the superadjacent sediments an English coin was found, and the oars of a boat were dug up. When a little water entered this peaty and shelly deposite, from the adjacent upper magnesian limestone, it produced in the wood a singular petre-

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faction, for the external bark and wood were converted into carbonate of lime, in which the vegetable structure was perfectly preserved. In like manner some of the nuts were opened, and the shells and membranes lining them were unchanged, but the kernels were converted into carbonate of lime, not crystalized, but retaining the peculiar texture of the recent fruit. In this particular case no reasonable doubt can exist, that the peaty deposite, full of land mosses, hazel bushes, and fresh water shells, was water-moved, and covered up by fine sediment from the river and the tide. As with the example now mentioned, so with numerous accumulations of trunks, roots, and branches of trees, found in silted up estuaries, and in the heads of bays, both along our own coasts and other sea-boards.

PETREFACTIONS.

Before entering upon a description of fossil remains, I wish to correct a popular error in regard to petrefactions. The opinion has been entertained that in the course of petrefaction wood is changed to stone, and so of other substances. The true condition appears to be, that as the wood or other substance decays, its place is supplied by particles of stony matter, deposited either from water or earth, and as these particles must be exceedingly small, and the process of decay slow, oftentimes the fibrous structure of the wood is preserved after the wood has disappeared. Wood never undergoes this change

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only when it becomes spongy by decay, and all other constituents have gone except ligneous fibre. There are two kinds of petrefactions, one caused by infiltration of calcareous, and the other silicious particles.

FOSSIL REMAINS.

SAURIANS.—Says a distinguished writer: "The ocean of the Jurassic epoch also had its peculiar characters. It was inhabited by Saurians, eminently swimmers, the ichthyosaurus and pleisiosaurus, whose paws, in form of paddles, remind us of the chelonians of the present day. These voracious animals, all aquatic, took the place of the sauroid fishes of the carbonifierous group, which had now disappeared. At the same period lived those flying Saurians called pterodactyls, which peopled the air, and completed the series of singular creatures of an ancient creation, but now entirely annihilated."

ICHTHYOSAURUS.—In this animal we see the muzzle of the dolphin, the teeth of a crocodile, the head and breast of a lizard, the paddles of a turtle, and the back-bone of a fish. No entire skeleton of this animal has yet been found, but fragments have been collected in the limestone formations of England. The length of the largest of these reptiles must have exceeded thirty feet. Its singular combination of structure, together with the vast number of bones composing its skeleton, have rendered it one of the most curious and interesting objects ever presented to

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the naturalist. The number of the vertebræ amount to ninety, and the number of pieces of bone contained in each paddle is one hundred. It was an amphibious animal, but lived chiefly in the water, as is indicated by the form of its paddles, which hardly could have permitted it to crawl upon the shore. It was an air-breathing animal, and if cast upon the shore it must have remained motionless and died, as whales do in like circumstances. The teeth of this animal numbered thirty in each jaw, being straight and sharp pointed. The enormous size of the eye must have given a most striking and terrific appearance to this strange animal. The comparative size of the eye-socket, when compared with the other parts of the head, will give us some idea of the frightful appearance of this animal, as well as the long rows of teeth with which his jaws were studded, of the power to seize and hold his prey. From the dimensions of his head, we may suppose the eyes to be at least six inches in diameter.

Dinotherium.—"The Dinotherium is the largest of the terrestrial mammalia of whose existence we have any positive knowledge, but it is not absolutely certain at present of what nature its extremities may have been, as we are hardly in a condition to speak very decidedly of its general appearance or habits. It is chiefly known by the fragments of the head and teeth, the former of which exhibit a near approach to the cetacean tribe, and the latter to the tapir; but there

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is a remarkable and very striking anomaly in the existence of two large and heavy tusks, placed at the extremity of the lower jaw, and curved downwards like the tusks in the upper jaw of the walrus. It is probable, from the size and position of these tusks, as well as from the structure of the bones of the head, that the animal was aquatic in its habits, living almost entirely in the water, and feeding on such succulent plants as it could there obtain. The length of this animal is estimated to be at least eighteen feet, and its proportions were probably very much like those of the great American tapir. It was provided with a trunk which seems to have been short but extremely powerful, and capable of being employed to tear up the food which the tusks, acting like pick-axes, may have loosened. This animal belongs to the race pachydermata."—*Ansted.*

MEGATHERIUM.

The DILUVIUM covers up the tertiary deposites, and contains fossils whose origin dates back to a period not very long antecedent to the present. In fact the diluvium to a certain extent unites the tertiary with the recent period. It contains the bones of large mammals both of extinct and recent genera and species. Among them we may place the enormous Megatherium which is not less than eighteen feet long and nine feet high; some are probably much larger.

"In regard to the habits of this animal, the teeth," says Dr. Ure, "proved that it lived on

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vegetables, and its robust fore-feet, armed with strong, sharp claws, testify that it was chiefly their roots that it sought after. Its magnitude and talons supplied it with abundant means of defence. It was not swift in running, but this was unnecessary, as it has no occasion to pursue or fly. It would therefore be difficult to find in its organization alone the causes of the final destruction of this genus; yet if it still exists where can it be? How could it have escaped the researches of hunters and naturalists. Its analogies approximate it to different genera of the edental or toothless family of animals. It has the head and shoulders of a sloth, a creature possessing both tusks and grinders, while its limbs and feet exhibit a singular mixture of characters belonging to the ant-eaters and armadillos. It has no analogy whatever to the feline or tiger tribe. This animal has neither tusks nor proboscis like the mastodon and elephant; this is proved by the great length of the neck, which it is apparent could not have supported such an apparatus. As its fore-parts are exceedingly strong, and its teeth not formed for tearing flesh, its claws were probably employed in digging for the roots of trees for food, and if so, there is a probability that it burrowed in the earth. What a phenomenon! An animal of the size of an elephant running about under ground like a mole, leaving a path after him large enough for a horse and wagon to follow.

To the diluvial drift are also referred the great

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collections of bones in the *icy ocean*, on the coast of Siberia and the neighboring islands. There a number of enormous animals, their flesh preserved through thousands of years, lie buried in sands consolidated by perpetual ice. In these situations have been found stags, elephants, and rhinoceroses covered with hair, indicating that the species that then lived in northern climates were enabled to bear, from being clothed in fur, lower temperatures than those with naked skins, which now inhabit Southern Asia, and Africa.

PLESIOSAURUS.—"In this reptile we have the same turtle-like paddles, a lizard's head, and a long neck like the body of a serpent. The most singular part of its construction is the immense length of the neck, the shortness of the tail, and the disproportion of the other parts. The neck is composed of a greater number of bones than that of any known animal. In a living state it must have presented a neck resembling a large serpent, and its extremities, like those of the ichthyosaurus, were genuine fins like those of the whale tribe. That this animal was aquatic in its habits is evident from its fins, and that its element was the sea may be inferred from the marine remains with which its bones are everywhere associated. Its motions on the land must have been awkward and difficult, and its long neck would impede its progress through the water. It was an air-breathing animal, and might have swam along the surface, arching its neck

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like a swan, and now and then darting down its head to catch the fish below," and to a credulous mind might also have suggested the idea of a monstrous sea serpent. There are several varieties of this reptile.

PTERODACTYLUS.—This was a kind of flying Saurian whose head gave it the semblance of a bird, and its tail was like that of a mammal, while its extremities were analogous to those of a bat. It was capable of walking and flying, and perhaps of climbing steep rocks in pursuit of food.

MASTODON.—The whole of the genus Mastodon are extinct. The remains of the Great Mastodon have been found principally in North America. In 1802, Mr. Peale, of Philadelphia, procured numerous bones of this animal from the neighborhood of Newburgh, on the Hudson river, and formed two entire skeletons out of them by supplying with wood those parts which were wanting.

In size, the Great Mastodon was about that of the elephant, though it does not appear in general to have been more than twelve feet in height, (the Indian elephant being sometimes fifteen.) Its tusks, trunk, and feet, and the bones of the whole skeleton, were very similar to those of the elephant; the difference being chiefly in the dental system with respect to the grinders. The number of grinders in a full grown Mastodon is four in each jaw. Of these, the two front ones in the upper jaw have six points, and the other

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two, in the same jaw, have eight. In the lower jaw, the two anterior ones have also six points, and the two posterior ones ten. The largest grinders of the Mastodon weigh from ten to twelve pounds.

RESTORATION OF THE PACHYDERMATA.—"It is chiefly in the lower parts of the gypsum of the tertiary formation that these extinct quadrupeds are found. Such, for example, are the *anoplotherium* and *paleotherium*, pachydermatous animals, more or less approaching to the rhinoceros and tapir, of which there are several species."

"The common ANOPLOTHERIUM was about the size of an ass, of a heavy form, with thick short legs and a long tail. Some species had slender legs, and must have been swift and active, and others were of the size of a hare, and even of a guinea pig, which were nevertheless adult."

The PALEOTHERIUM was about the size of a horse and form of a tapir. Species of various sizes, both large and small, existed. They had thick, hard skins, which could not be easily penetrated.

CALIFORNIA.

We now come to a realized El Dorado—a veritable *terra d'oro*, towards which the tide of emigration is now setting from all quarters of the Earth. Upper California, or that part of Western America recently ceded to the United States, is embraced between latitude 32° and 42° north, and between longitude 109°.

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west and the Pacific ocean, containing about 400,000 square miles. That part east of the Colorado, whose southern boundary rests on the Gila, is entirely occupied by broken mountain ranges, with narrow valleys intervening. The general features of the central part, lying between the Colorado and the Sierra Nevada, are those of a semi-desert, the north part forming a great basin, which is 400 miles in extent from east to west, by 250 from north to south, and elevated some 5,000 feet above the ocean, having a succession of isolated mountain ranges, running north and south, their general outline being sharp and rugged. This great valley contains the Great-salt plain, which is forty miles broad and one hundred and fifty long, with a snow-like incrustation of saline and alkaline bodies, and very compact and hard on its eastern border. The crust is from one quarter to half an inch thick, beneath which is a stratum of damp whitish sand and clay intermingled; fragments of white shelly rock are strewn over the entire plain, and imbedded in the salt and sand. To the west the soil becomes softer, being composed of clay, sand, and salt.

The section west of the California range, comprising three-tenths of the territory, and to which the world's attention is now turned by the discovery of its mineral riches, embraces three valleys, the Sacramento, San Joachin, and San Juan. The first extends from 40° 30" north to the south one hundred and eighty miles, and is an inclined

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prairie of alluvial, rising about four feet to the mile, and divided into two distinct terraces throughout its length, called the upper and low prairies. The low undulating hills which form the upper prairie, project into the lower prairie to various distances, and gives its boundary an irregular outline; the height of this upper prairie above the lower is about sixty feet, the slope varying, and, in some instances, is very steep. The upper prairie is about two hundred and fifty feet above the level of the river, and inclines to the south. Its undulating hills consist of a clayey and sandy loam, gravel, and pebbles, while the soil of the lower prairie is rich alluvial. The Bute hills rise to the height of 1,794 feet above the plain, the base being nearly on a level with the upper prairie. The valley of San Joachin is one hundred and forty miles long, and fifty wide; its lower prairie is almost wanting, yet it has two distinct elevations, the difference in level averaging forty feet. The valley is three hundred miles long and sixty broad, being elevated only a few hundred feet above the level of the sea. The surface along the lakes and river consists of level plains, changing into undulating ground nearer the foot hills of the mountains. Both lakes are surrounded by extensive sloughs, the earth being a rich alluvial deposite from the surrounding mountains. The valley of San Juan is situated at the south of San Francisco bay, being sixty miles long, and from fifteen to twenty in width. It is apparently a level plain, but ascends gradu-

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ally towards the south; the plain extends to the foot of the high hills on the east, but on the west it has the undulating hills of the Sacramento valley, but not their irregular outline.

The upper part of the Sacramento valley is one hundred miles long, the lower two hundred. The terrace is mostly about sixty feet high; but the upper plain gradually rises to one hundred and fifty or two hundred feet. On the plains nothing but mineral deposites are met with until reaching the Sacramento Bute, which is an ancient crater, consisting of trachyte and trachytic porphyry. It will become valuable for its stone quarries. The gold district lies north of San Francisco, being a broad tract enclosed on the east by a lofty and recently elevated tract, partly trachytic, but every where exhibiting igneous rocks. The metal has hitherto been obtained from alluvial sand and gravel, being mixed with and forming part of quartz rock and pebbles, occurring in the mud and gravel which form the present beds of streams, and also in the former and now dry beds of such streams. The crevices of rocks also contain a good supply.

The gravel of the district is the rock pulverized by natural causes. The streams washing over the soil, still farther aid in the preparation, by collecting the gold into the bottom of the valleys and carrying off the light gravel and sand, thus leaving the grains of metal along the beds of the streams and the bottoms of ravines. The region covered by the debris of the mountains is

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as wide as the vast prairies of its long-reaching rivers, and the slopes that rise into the ranges on either side. The gravel of these slopes, and the stratified earth and gravel of the plains may therefore contain gold; but the parts more nearly in the vicinity of the particular auriferous rocks, naturally prove most productive. Compact, slightly glistening, slaty rocks, of various dark colors, the talcose, more or less greasy in look or feel, and often greenish, and chloritic, mostly of a darker olive-green color, contain often beds or veins of quartz in which the gold is found. Dikes or beds of quartz rock, many feet in thickness, and often of great length, are numerous, and generally among nearly vertical strata of slate or gneiss rock. The diluvium, where the diggings have been carried on, varies from half a foot to several feet in thickness, and rests, unconformably, on a bed of argillite or gneiss, running about north-northwest and south-southeast, and dipping nearly perpendicularly. The clay slate presents a very irregular surface, with abundant little pockets for retaining the gold, which is found most plentifully on its surface and in its crevices. Where the gold is dug from the ravines, the underlying rock is some form of this slate; and on the river, the gold stratum rests on a stratum of coarse granitic sand. The richest excavations have been in the bottoms of dry ravines, though gold is found on the slopes, and even on the summits of hills.

The dry diggings, which is an upland

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marsh, is considered preferable to the wet. In the former, the metal is found in lumps, and in the crevices of rocks, and lies from a few inches to three or four feet below the surface. In the latter, it occurs in flakes or scales. In the streams, the usual process of procuring it is by throwing up dikes and turning the water from its channel, or drawing portions of the river's bed. In the eddies of the main stream it can be seen in great abundance, and at a depth of twenty-five or thirty feet in many places.

Auriferous districts and mountains are rarely limited to small areas, and the fact that no part of the world contains a larger mass of porphyries than the Cordillera, renders probable the existence of a considerable tract over which similar repositories exist. It is reported that gold occurs near Tule lake, near Monterey, on the east side of the Sierra Nevada; and that a rich placer has been discovered near the boundary line between California and Oregon. The porphyriceous chain, of which the range in California is a part, extends almost in the direction of a meridian, 7,500 miles from one hemisphere to the other, and throughout its whole length appears highly metalliferous; but amidst many indications of aureate deposites, no mine has yet been discovered which can be compared in richness to those of the wide and more than Pactolian plains,

> "Where Sacramento floats the desert lands,
> And leaves a rich manure of golden sands."

But great as are the discoveries of gold, they

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are equalled by those of mercury. It is found in various places, even within three miles of San Francisco. Forbes's mine is situated near San Juan, in a spur of the mountains, 1,000 feet above the level of the bay of San Francisco. The cinnabar occurs in a large vein dipping at a strong angle to the horizon. Lead mines exist at Sonoma. The other metals are platinum, silver, copper, iron, and tin. Sulphur, nitre, muriate of soda, and bitumen, abound; bituminous coal is known to exist.

From official analysis, we learn that the gold dust yields $93\frac{2}{3}$ pure gold; the melted metal yielding within $\frac{6}{1000}$ or $6 in the $1,000 of the mint standard of 900. In the assays of the melted gold, the results showed a variance in fineness from 892 to 897 thousandths; the average of the whole being 894. The average value per ounce of the bullion assayed, before melting, was $18·05½; that of the same in bars, after melting, $15·50. The specimens of cinnabar yielding nearly one-third of their weight in mercury.

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GENERAL REMARKS RELATING TO THE CHART.

I. The Chart represents the succession of systems and strata as they would succeed each other if all were present at one place. But as at no place all the rocks occur, it is only an ideal representation of succession in time. Any series, and indeed entire systems, are absent in almost every locality. Hence, the great labor which has been expended by geologists in determining the true order of succession in the entire series. An example of the absence of rocks is furnished in the New York System. Thus in the Hudson valley, the Medina sandstone, the Onondaga salt group, the Niagara limestone and the green shales below, are all absent; these being developed only in the central part of the state. In this valley, therefore, the Manlius waterlimes and their shaly beds rest down upon the superior members of the Hudson river group. We may find any part of the sedimentary rocks resting upon the primary—thus the coal series near Richmond, in Virginia, rest upon the primary rocks. The tertiary of the Hudson and Champlain valleys upon

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the Trenton limestone or Hudson river slates, &c. Sometimes the absence of rocks is effected by the thinning out of members, as the deltryris shaly limestone thins out and disappears as it goes west from the Hudson valley.

II. The Chart represents the intrusion and upward thrust of igneous rocks, as greenstone, porphyry, basalt and lavas. These intrusions have occurred at different periods. Basalt is a compact lava, cooled under great pressure, and is often columnar, as is represented in the right upper corner; its origin is represented by a slight conical prominence, colored red. Igneous rocks, as basalt and porphyry, are spread out sometimes similar to sedimentary rocks, as the reddish porphyry upon Lake Champlain, near Essex; or intruded between the beds of sandstone to some extent, as the greenstone of the Palisadoes above New York.

III. Rocks are often disturbed and bent upward as represented on the Chart, when they come in contact with granite and other rocks.

IV. Rocks, and portions of them, have been swept away by diluvial action as represented in the curvatures of the coal rocks.

V. The New York rocks embrace the Taconic, silurean and devonian systems, with a part of the carboniferous and the tertiary deposits, as will be seen by reference to the Chart.

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FOSSILS

OF THE

DIFFERENT FORMATIONS

DELINEATED UPON THE CHART.

TERTIARY.

Nos.		Localities.
1	Pecten pleuronectes,	Subappenine beds.
2	Tooth of a Mastodon (reduced),	Banks of the Hudson.
3	Cyprea coccinelloides,	Subappenine beds.
4	Voluta Lamberti,	Coralline crag.
5	Leaf of an Elm,	Miocene deposits.
6	Comptonia acutiloba (fern),	do.
7	The lower jaw and tusk of the Dinotherium giganteum,	do.
8	Palmacites Lamanonis (palm),	do.
9	Paleotherium magnum,	Eocene.
10	Paleotherium minus,	do.
11	Anoplotherium commune,	do.
12	Cardium porulosum,	do.
13	Do. (inverted),	do.
14	Lymnea longiscata,	do.
17	Do. (inverted),	do.
15	Planorbis euomphalus,	do.
16	Crassatella sulcata (London clay),	do.
18	Turritella imbricataria,	Tertiary.

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Nos.		Localities.
19	Milleolites (greatly magnified),	do.
20	Do. (inverted),	do.
21	Ampullaria acuta,	do.
22	Terebellum fusiforme (Lond. clay,	do.
23	Cerithium giganteum (much reduced)	do.
24	No. 16 inverted,	Eocene.
25	Mitra scabra (London clay),	Tertiary.
26	Rostellaria pespelicani,	do.
27	Pleurotoma rotata,	Pliocene.
28	Buccinum prismaticum,	do.
29	Megatherium,	Diluvium.

SECONDARY.

30	Hippurites bioculata,	Cretaceous.
31	Plagiostoma spinosum,	Upper cretaceous.
32	Chama ammonia,	Cretaceous.
33	Nummulites,	From Chalk.
34	Mantellia nidiformis,	Portland stone of the Jurassic.
35	Mya rugosa,	do.
36	Ostrea acuminata,	Lower Oolite.
37	Pterophyllum Williamsoni,	do.
38	Terebratula digona,	do.
39	Pterodactylus crassirostris,	The Lias.
40	Plesiosaurus dolichodeirus,	do.
41	Microdon (Family Pycnodontes),	Oolite.
42	Pterophyllum,	Trias.
43	Lepidodendron elegans,	Carboniferous.
56	Plicatula placunea,	Green sand of the Cretaceous.

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Nos.		Localities.
57	Trioceratites Duvallii,	Cretaceous.
58	Lima elegans,	do.
59	Belemnites mucronatus,	Chalk marl.
60	Exogyra columba,	do.
61	Trigonia alæformis,	Cretaceous.
62	Ammonites rothomagensis,	Chalk.
63	Ammonites varians,	Chalk.

OLDER PALEOZOIC.

86	Osteolepis,	Old red sandstone
87	Calymene (trilobite rolled up),	Dudley limestone, England
89	Do. macrophthalmus (rolled up),	do.
88	Asaphus tuberculatus,	do.
90	Paradoxides (of Brongniart).	
92	Ogygia do.	
91	Asaphus De Buchii,	Slate of Llandilo.

NEW YORK ROCKS.

44	Cypricardites ovata,	Loraine shale.
45	Delthyris,	Grey limestone.
46	Subulites elongata.	
47	Bellerophon bilobatus,	Trenton limestone,
48	Pleurotomaria lenticularis,	do.
49	Atrypa lævis,	Catskill shaly limestone.
50	Trinucleus caractaci,	Bluish slate.
51	Cypricardites,	Hudson River group.
52	Littorina cancellata,	Clinton group.
53	Strophomena,	Grey sandstone.
54	Strophomena nasuta,	do.

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Nos.		Localities.
55	Trocholites ammonius,	Mohawk valley and Jefferson county.
65	Delthyris niagarensis,	Niagara group.
66	Delthyris radiatus,	do.
67	Conularia trentonensis,	Trenton limestone.
68	Atrypa, ———	Corniferous limestone.
69	Cyathocrinus,	Niagara group.
70	Delthyris,	Hamilton group.
71	Orthis bisulcata,	Hudson River group.
72	Atrypa lacunosa,	Pentamerus limestone.
73	Lingula quadrata,	Trenton limestone.
74	Atrypa,	Encrinal limestone.
75	Delthyris mesastrialis,	Chemung group.
76	Pleurorhyncus, ——	Corniferous limestone.
77	Orthonota undulata,	Hamilton group,
78	Delthyris mucronatus,	do.
79	Pentamerus galeatus,	Pentamerus limestone
80	Homalonotus delphinocephalus (trilobite),	Niagara group.
81	Cyathophyllum dianthus (coral),	Onondaga salt group.
82	Atrypa medialis,	Catskill shaly limestone.
83	Atrypa naviformis,	Clinton group.
84	Delthyris ? ———	Chemung group.
85	Delthyris macropleura (big-ribbed),	Shaly limestone.

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GLOSSARY.

The following abbreviations are used:—Lat., Latin; fr. Lat., from the Latin; Fr., French; fr. Fr., from the French; Ger. German; fr. Ger., from the German; Gr., Greek; fr. Gr., from the Greek; It., Italian; fr. It., from the Italian; sing., plur., for singular and plural.

ACEPHALOUS, (fr. Gr.)—Without a head, headless.

Acicular—In the form of needles.

Actinolite, (fr. Gr.)—A variety of hornblende which occurs in fascicular crystals.

Acuminata, (Lat.)—Pointed, peaked.

Acuta, (Lat.)—Acute, sharp pointed.

Acuticosta, (Lat.)—Having pointed ribs or sides.

Acutiloba, (Lat.)—Having sharp pointed lobes.

Adherent—United with, or to, sticking.

Agate, (fr. Gr.)—An aggregate of certain siliceous minerals, chiefly chalcedony, variously colored.

Agglomerato, (fr. Lat.)—To gather together masses made up of parts.

Aggregate, (fr. Lat.)—To collect or heap together.

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Aleformis, (Lat.)—Wing-shaped.

Alluvium, *Alluvion*, (Lat.)—Gravel, sand, mud, and other transported matter, washed down by rivers and floods upon land not permanently submerged beneath water. A deposit formed of transported matter.

Alluvial—Of the nature of alluvium.

Alumina, (Lat.)—Alum. Pure Argil. The basis of alum, one of the earths.

Amblypterus, (fr. Gr.)—AMBLUS, obtuse, PTERON, wing. A fossil fish.

Amianthus, (Lat.)—Flexible asbestus.

Ammonia, (Lat.)—Relating to Ammon, a name of Jupiter. Specific name of a fossil shell.

Ammonite—A fossil shell, rolled up like a coiled serpent.

Ampularia, (fr. Lat.)—A round, swelled out bottle. Name of a genus of snails.

Amorphus, (fr. Gr.)—Without form. Shapeless.

Amygdaloid, (fr. Gr.)—Almond-shaped. Applied to certain rocks in which other minerals are imbedded like almond in a cake. A particular form of volcanic rock.

Analogy, (fr. Gr.)—Resemblance or relation things bear to each other.

Anhydrous, (fr. Gr.)—Without water. Applied to certain salts and acids deprived of water.

Ananchytes,—A genus of fossil sea-urchins.

Anthracite, (fr. Gr.)—A kind of stone coal, difficult to inflame.

Anoplotherium, (fr. Gr.)—An unarmed wild beast.

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Aquatic, (fr. Lat.)—Relating or belonging to water.

Aquilina, (Lat.)—Of or like an eagle. Rapacious.

Aqueous, (fr. Lat.)—Watery. Consisting of water.

Arenaceous, (fr. Lat.)—Sandy, of the nature of sand.

Argil—Clay, old name of alumina.

Argillite—A slaty rock of fine texture.

Argillaceous—Of the nature of clay.

Asaphus, (fr. Gr.)—Obscure. A name devised to express the obscure nature of a genus of trilobites. Fossil crustaceans.

Asbestus, (fr. Gr.)—Unconsumable. A fibrous soft mineral, composed of separable filaments, of a silky lustre.

Astarte—Name of a genus of fossil bivalve shells.

Augite—A mineral the same as Pyroxene, resembling hornblende.

Avicular, (fr. Lat.)—Name of a genus of bivalve molusks.

Basalt—A rock essentially composed of felspar and augite, of compact texture, and dark green, gray, or black color. It occurs in columnar masses. Basalt closely resembles greenstone.

Basaltic—Of the nature of basalt.

Basanite—A kind of siliceous slate commonly known under the name of *touchstone*. It

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has been used to determine the purity of gold and silver.

Belemnite, (fr. Gr.)—A word which signifies dart. A genus of fossils the shells of which are chambered and perforated by a siphon. They are long, straight and conical, and commonly called thunder-stones.

Bellerophon, (fr. Gr.)—A genus of cephalopods which inhabited chambered shells similar to those of the argonaut and nautilus.

Bicordatus, (Lat.) — Bicordati, double-heart shaped.

Bioculata, (fr. Lat.)—Two eyed, having two eyes.

Bitumen, (fr. Gr.)—A variety of inflammable mineral substances resembling pitch.

Bivalve, (fr. Lat.)—Shells composed of two pieces united by a hinge are termed Bivalves.

Blende—Sulphuret of zinc, a common shining zinc ore.

Botryoidal—Smooth rounded masses, clustered like a bunch of grapes.

Boulders—Large irregularly shaped rocks.

Buccinum, (Lat.)—A trumpet or horn. Name of a genus of mollusks.

Bucklandii—Dr. Buckland Latinized. Specific name of certain fossils in honor of Dr. Buckland.

CALCAREOUS, (fr. Lat.)—Lime. Containing lime.

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Calciferous, (fr. Lat. Calx.)—Lime. Producing lime.

Calcined, (fr. Lat.)—Converted into a friable substance or lime by the action of fire.

Capillary—Resembling a hair, minute, slender.

Carbon, (fr. Lat.)—The pure inflammable principle of charcoal. In its state of absolute purity it contains the diamond.

Carbonate—A compound of carbonic acid with a salifiable base. Carbonate of lime, for example, is a compound of carbonic acid with lime, constituting chalk, limestone, marble, etc.

Carbonaceous—Belonging or relating to carbon.

Carboniferous, (fr. Lat.)—Containing carbon.

Carburet—A combination of carbon with a metal or other substance. Steel and black lead are carburets of iron.

Cardium, (Lat.)—A cockle. A genus of bivalve shell.

Carnelian—A precious stone, either red or white.

Cemented—Joined together by cement.

Cephalaspis—A genus of fossil fishes with a shield-like head.

Cephaloped, (fr. Gr.)—A mollusk, which has the head situated between the body and feet.

Cerithium—A genus of turriculated univalve mollusks, both recent and fossil.

Cetacea, (fr. Gr.)—A whale. Name of an order of mammals.

Chalcedony—A semi-transparent mineral, apparently formed by the infiltration of siliceous matter in a state of solution.

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Chalk—Earthy carbonate of lime.
Chalybeate—Water containing iron in solution.
Chlorite, (fr. Gr.)—A soft, green, scaly mineral, slightly unctuous.
Cleavage—The mechanical division of rocks; the laminæ of rocks and minerals.
Clinkstone, or Phonolite—A species of compact basalt which is sonorous when struck.
Coccinelloides—Resembling the cochineal insect.
Columba, (Lat.)—A dove; specific name of a fossil shell.
Columnar, (Lat.)—In the form of a column.
Commune, (Lat.)—Common.
Comptonia—A genus of plants in honor of Henry Compton.
Conglomerate—A rock composed of pebbles, cemented by another mineral substance, either calcareous, siliceous, or argillaceous.
Coral—The hard calcareous support formed by certain polypi.
Coraline—Relating to coral.
Cornbrash—An oolitic bed consisting of clays and sandstones.
Costatus, (Lat.]—Ribbed,
Crag—A variable heap of gravelly strata.
Crassatella—A genus of bivalve shells.
Crater—The mouth of a volcano.
Cretaceous, (fr. Lat.)—Of the nature of chalk.
Crioceratites—A fossil cephaloped, resembling a ram's horn.
Crustaceous—Animals covered by a crust, as the crab and lobster.

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Crystaline—Relating to crystal.
Crystalize—To form crystals.
Cyprea, (fr. Cr.)—A genus of gasteropod mollusks.

Debris, (Fr.)—Wreck, ruins, remains.
Delta—Alluvial formations deposited at the mouth of a river. The new made land changes the current of the stream and forms the delta.
Deposit—Something laid up or placed in a firm position.
Deposition—The falling to the bottom of matters suspended or dissolved in water or other liquid.
Depression—Sunk down, or lowered.
Detritus, (fr. Lat.)—Bruised, worn; rubbed one against another.
Diallage—A mineral of foliated structure, easily divisible in one direction.
Diadema—A crown; a genus of echinidea.
Digona—Having two angles.
Diluvium—Deposits of gravel and clay, with boulders formed by unusual operations of water.
Dinotherium, (fr. Gr.)—Dinos, round, and Therion, a beast.
Diorite—A variety of trap rock consisting of albite and hornblende.
Dip—Direction of the inclination of strata.
Disintegrated—Separated, divided, broken up.
Dolomite—Granular magnesian carbonate of lime.

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Drift—Superficial deposits of water-worn, transported materials, consisting of gravel, boulders, sand, clay, etc.

EDENTATA—An order of mammals without teeth.
Effervesce—To boil; to produce commotion of fluids by the sudden escape of gas in the form of bubbles.
Elegans, (Lat.)—Elegant.
Encrinites—A species of animal and plant, a genus of echinoderms.
Eocene, (fr. Gr.)—*Eos*, dawn, and *kainos*, recent, the first dawn of existing species.
Epoch—The time from which dates are numbered.
Equisetum, (fr. Lat.)—*Equus*, horse, *seta*, hair; a genus of plants.
Erosion—The act of wearing away.
Eruption—The act of bursting from any confinement.
Escarpment—The steep face of an abrupt termination of a strata; a sharp point.
Euomphalus—A gasteropod mollusk.
Eurite—A particular form of granite, sometimes called felspar.
Exogyra—Not circular; a genus of unimuscular bivalves, allied to the oyster.
Exuviæ—Fossil animal remains of any description.

FASCICULAR (fr. Lat.)—In the form of a bundle.

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Fauna—The animals peculiar to a country, constitute the fauna of that country.
Felspar—A constituent of granite. See Felspar.
Felspathic—Of the nature of felspar.
Ferruginous, (fr. Lat.)—Containing iron.
Fibrous—Consisting of fibres.
Fissile—Easily split.
Fissure—A crack, an opening in a rock.
Flexible—Easily bent, pliant.
Foliated—In the form of leaves, leafy.
Fossil—A term applied to petrified vegetables, or remains dug out of the earth.
Friable—Easily broken down, earthy.
Fusiforme, (Lat.)—Spindle-shaped.

Galena—Lead ore, sulphuret of lead.
Garnet—A mineral consisting of silicates of alumina, lime, iron, and manganese.
Genus—A kindred, breed, race, or family.
Geology—The science of the earth.
Gibbous and *Gibbosity*—Protuberance.
Giganteum—Large, gigantic.
Glaciers—Masses or beds of ice formed in high mountains.
Globose—Round, globular
Gneiss—See Gneiss.
Granite—See Granite.
Granular—Consisting of grains.
Graphite—Black lead, a carburet of iron.
Graywacke—Gray rock of a slaty structure.
Greenstone—A tough variety of trap rock, principally hornblende.

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Gypsum—Plaster of Paris, native sulphate of lime.

Hematite—A red, or brown, kidney-shaped rock, of a fibrous metallic appearance.
Heterophylla—Specific name of a fossil plant.
Hexagonal—Having six-sided angles.
Hippurites—A genus of extinct mollusks, supposed to be bivalve.
Hornblende—A mineral of dark green or black color, abounding in oxyd of iron.
Hydrated—Containing water.
Hypersthene—Labrador hornblende, containing iron, silica and magnesia.
Hypnoides—A specific name of a fossil plant resembling moss.

Ichthyosaurus, (fr. Gr.)—The fish lizard.
Igneous, (fr. Lat.)—Relating or belonging to fire.
Imbricata—Arranged like tiles, tile-like.
Incandescent—The condition of great heat, as if the heated substance itself were burning; melted.
Inequivalvis—Having unequal valves.
Infiltration—The act of filtering through, producing an accumulation of liquid.
Inverted—Turned upside down, changed over.
Isolated—Separated, like an island.

Jasper—A siliceous mineral of various colors.
Jurassic—Belonging to the Jura mountains.

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KAOLIN—A variety of earth used for making fine porcelain.

LACUSTRINE—Belonging or relating to lakes.
Lamanosis—Specific name of a fossil plant.
Laminated—Plated; consisting of plates, scales, or layers, one above another.
Lamberti—Lambert, Latinized.
Lava—The substance which flows in a melted state from a volcano.
Layers—A stratum, a bed, a body spread over another.
Lepidoides—A genus of fossil plant, having a scaly bark.
Lignite—A kind of coal.
Lima, (Lat.)—A name of a genus of bivalves.
Liquefaction—The act of becoming liquid.
Lithologically—Relating to the position of rocks, or stones.
Lithographic Stones—Those used for the purposes of lithography.
Loam—A mixture of sand and clay.
Lydian Stone—A flinty slate.
Lymnea—A genus of fresh water snails.
Lustre—Brightness, shining appearance.

MAGNESIA—A white, tasteless, earthy substance.
Magnetic—Having the properties of the loadstone.
Magnum, (Lat.)—Great.
Mammal—Any animal that suckles its young.
Mammoth—An extinct species of the elephant.

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Manganese—A metal of a dusky white.
Mantellia—A genus of fossil cycadæ.
Marl—Argillaceous carbonate of lime.
Marine—Relating to the sea.
Mastodon—A genus of extinct quadrupeds allied to the elephant.
Magatherium, (fr. Gr.)—A great wild beast.
Metaliferous—Containing metals.
Metamorphic, (fr. Gr.)—*Meta*, indicating change, and *morphe*, form; change of form.
Mica—A mineral found in thin elastic laminæ, soft, smooth, and of various colors and degrees of transparency; a constituent of granite.
Milliolites—A genus of fossil shells resembling millet seed.
Minima, (Lat.,)—Least.
Minus, (Lat.)—Little.
Miocene—Having more recent species than the preceding group.
Mitra, (Lat.)—Mitre, an ornament worn on the head of a bishop.
Mollusks—Any animal of the class of mollusca.
Monileformis—In the form of a necklace.
Mya rugosa—A genus of wrinkled bivalve mollusks.

NAGELFLUE—A coarse conglomerate.
Nidiformis—In form of a bird's nest.
Nodosus—Knotty.
Nodule—A round, irregular lump or mass.

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Nummulites—Fossil money, an extinct genus of cephalopods.

Obsidian—A glassy lava; volcanic glass.
Octahedron—Eight-sided.
Oolite—A granular variety of carbonate of lime.
Organ—Part of an organized being.
Organic—Relating to organs.
Osseous—Bony, resembling bone.
Osteolepis—A fossil fish with bony scales, arranged by the side of each other, like bricks.
Ostrea—A genus of bivalves, an oyster.
Outcrop—The emergence of a rock at the surface.
Oxyd—A compound of oxygen and a base.

Pachydermata, (Lat.)—Thick skinned animals.
Palæozoic, (fr. Gr.)—*Palaios*, ancient, and *zoe*, life; relating to ancient life.
Paleontology—That branch of zoological science which treats of fossil organic remains.
Paleotherium, (fr. Gr.)—An extinct quadruped, resembling a tapir.
Palmacites—A genus of fossil plants.
Pecopteris—A genus of fossil ferns.
Pecten—A comb, a genus of bivalve mollusks.
Percolate—To strain, or drip through.
Peroxyd—The highest degree of oxydizement.
Pespelicani, (Lat.)—Pelican foot.
Pisiformis—Having the form of a pea.
Pholodomya—A genus of mollusks.

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Placunea—Broad, flat, even.
Plagiostoma—A genus of bivalve mollusks, with oblique mouths.
Planorbis—A genus of marsh snails, flat.
Platina—A heavy metal, resembling silver.
Platycephalus, (fr. Gr.)—Flat-headed.
Platysomus—Having a flat body; a fish fossil.
Pleistocene—The newest formation, or the most recent.
Pleurotoma—A genus of univalve mollusks, having a notch in the shell.
Pleuronectes—A genus of fishes which swim on the side.
Plicatula—A genus of mollusk.
Pliocene—More recent.
Plutonic—After Pluto, the god of fire; relating to fire.
Pterodactylus—A flying saurian.
Pterophyllum—A genus of fossil plants.
Pudding Stone—A conglomerate.
Pumice—Vesicular obsidian.
Pyrites—A compound of sulphur and iron.
Pyroxene—A rock not formed by fire.

QUARTZ—Rock crystal, a constituent of granite.
Quartzose—of the nature of quartz.

RADIATA—The name of a class of zoophites.
Rag—A variable series of coarse shelly limestone.
Resinous—Containing resin, pitch.
Reticulated—Having the texture of a net.

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Rostellaria—A genus of univalve mollusks.
Rotata—Wheel-shaped.

Saccharoid—Resembling loaf sugar.
Saliferous—Producing salt.
Saurian—Animals of the lizard tribe.
Scabra, (Lat.)—Rough.
Schist—Clay slate, easily split.
Schistose—Slaty.
Schorl—A brittle, lustrous substance, in the form of black, prismatic crystals.
Scoriæ—Volcanic cinders, lavas of a reddish brown, or black color.
Sedimentary—Relating to sediment, settled to the bottom.
Segregated—Separated, parted.
Sella, (Lat.)—A saddle.
Seriale, (Lat.,)—Jar-like.
Serpentine—A magnesian rock of various colors, generally dark green.
Sienite—A granitic rock, consisting of quartz, felspar, and hornblende, tougher than granite, and more durable.
Silex—The principal constituent of quartz, rock crystal, flint, and other siliceous minerals.
Silica—Siliceous earth.
Silt—Sand. clay, and earth, which accumulates in running water.
Sinuous—An irregular winding.
Spenophillites—A family of fossil plants.
Spenopteris—A fern, a genus of fossil plants.
Spirifer, (Lat.)—A wreath-like fossil shell.

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Stalactite—Conical concretions of the carbonate of lime attached to the roofs of calcareous caverns.

Stalagmites—Formations of the carbonate of lime on the floors of calcareous caverns.

Steatite—Soapstone.

Stratum, (Lat.)—A layer, a bed.

Strata—Plur. of stratum.

Stratified—Arranged in layers.

Striated—Marked with channels or creases.

Sulcatus, (Lat.)—A furrow, a groove.

TABULAR—Horizontal, in the form of a table.

Talc—A foliated magnesian mineral, of an unctuous feel.

Talcose—Of the nature of talc.

Technical—Pertaining to a particular art, science or profession.

Terebellum—A genus of gasteropod mollusks.

Terebratula—A genus of fossil shells.

Thermal—Warm, hot.

Toadstone—A sort of trap rock.

Tortuous—Winding.

Trachyte—A variety of lava.

Transparent—Admitting light to pass through, clear.

Translucent—Admitting light to pass through, but not sufficiently to make objects clearly visible.

Trap—Applied to certain igneous rocks.

Travertin—Limestone, deposited from water holding carbonate of lime in solution.

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Trigonia—Three-cornered, an extinct genus of bivalve mollusks.
Trilobites—A class of crustacean fossils, composed of three parts.
Triturate—To rub, or grind to a very fine powder,
Tufa—A stone, or porous substance, sometimes volcanic.
Turritella—A genus of gasteropods.

UNDULATING—Arranged in a wave-like manner.
Undulatus—Waved, having a waved surface.
Unstratified—Not arranged in layers.

VARIANS—Varying, changing.
Vascular–Containing numerous vessels.
Vertebræ—Joints or bones of the spine.
Vitreous—Resembling glass.
Volcanic—Relating to a volcano.
Voluta—A whorl, a genus of gasteropods.
Voltzia—A genus of fossil conifers.

WALCHIA—A genus of fossil conifer.
Whinstone—A Scotch name for greenstone and other trap rocks.

ZOOPHYTE—A plant-animal which partakes of properties of both plants and animals.

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